TRANSACTIONS

of the

American Society for Steel Treating

Vol. VIII October, 1925 No. 4

NEW OFFICERS NOMINATED

THE National Nominating committee, meeting according to the constitution of the American Society for Steel Treating, held its anual meeting on Monday, September 14, 1925, and nominated the following as officers of the Society:

For President—R. M. Bird
For Vice-President—J. F. Harper
For Treasurer—Zay Jeffries
For Director—R. G. Guthrie
For Director—H. Bornstein

The report of the Nominating committee appears on page 418 of this issue of TRANSACTIONS.

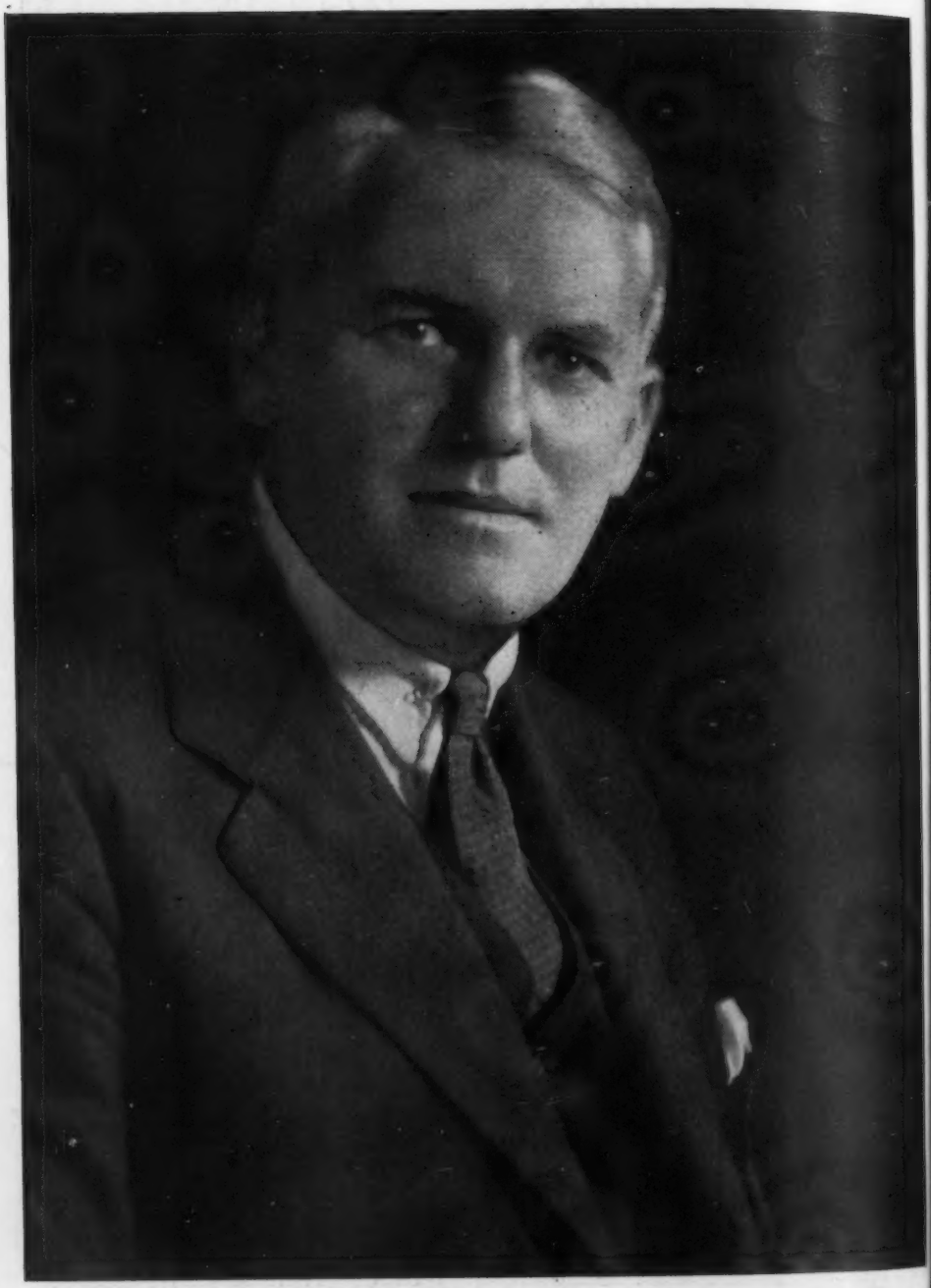
Elections will be made by letter ballot according to the constitution of the Society. Ballots will be sent to the members of the Society later in the fall.

BIOGRAPHIES OF NOMINEES

Robert M. Bird

Nominated President of the Society

ROBERT M. BIRD was born in Bethlehem, Pa., September 17, 1882, and received his early education in the Moravian parochial school of that city. He completed his education at Lehigh University, Bethlehem, from which institution he was graduated in 1902 with the degree of M. E. Immediately after graduation he entered the employ of the Bethlehem Steel Co., Bethlehem, with which company he was associated in various capacities until January 1, 1924. During this period he served successively as superintendent of heat treatment departments, superintendent of the Lehigh merchant

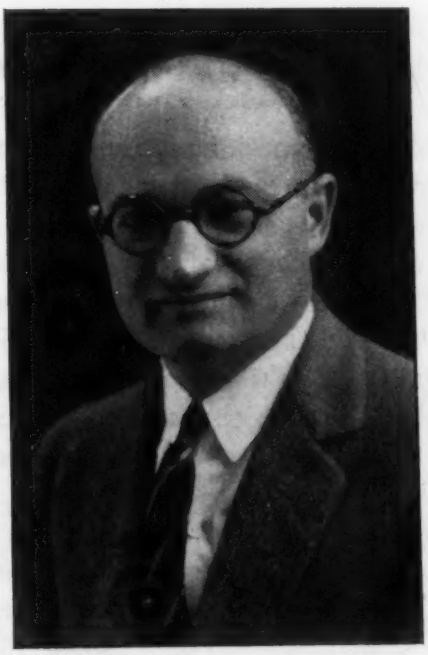


ROBERT M. BIRD
Nominee for President of the Society
for the Year 1926

J. FLETCHER HARPER
Nominee for Vice-President of the Society for the Year 1926

ZAY JEFFRIES
Nominee for Treasurer of the Society for Two Years (1926-27)

ROBERT G. GUTHRIE
Nominee for Director of the Society for Two Years (1926-27)



HYMAN BORNSTEIN
Nominee for Director of the Society for Two Years (1926-27)

mills, metallurgist, and for some time prior to his resignation he was engineer of tests.

Immediately after leaving the Bethlehem company, Mr. Bird associated himself with George F. Pettinos, Philadelphia, in the production and sales of foundry sands, supplies and graphites.

In 1921-22, Mr. Bird served as a member of the standards committee of the American Society for Steel Treating and in 1922-23 was made chairman of this committee. His work in organizing the recommended practice work of the Society brought him into prominence and resulted in his election to the second vice-presidency for 1923-24. In 1925 he became vice-president, which capacity he still fills.

In addition to his membership in the American Society for Steel Treating, Mr. Bird belongs to the American Society for Testing Materials, Society of Automotive Engineers, American Institute of Mining and Metallurgical Engineers, American Iron and Steel Institute and the Engineers' Club of Philadelphia. He is a member of the Kappa Alpha fraternity.

J. Fletcher Harper

Nominated Vice-President of the Society

ATTENDED the University of Wisconsin for three and one half years, taking electrical engineering, following which he served a special apprentice course at the Allis Chalmers Mfg. Co. Was connected with the Northwestern Mfg. Co., Milwaukee, for one year, returning to the Allis Chalmers Mfg. Co. in July, 1916, to take charge of the heat treating departments. In September, 1918, he was made assistant superintendent of the forge department in the same plant. In April, 1921, he was made research engineer of the manufacturing department of the Allis Chalmers Mfg. Co., which position he still holds.

Mr. Harper served as a member of the board of directors of the American Steel Treaters' Society during 1919-20. With the organization of the American Society for Steel Treating he was appointed chairman of the nominating and membership committees for 1920-21 and the chairmanship of the latter committee he retained in 1921-22. Since 1923 he has been a director and his nomination to the vice-presidency is in recognition of his unselfish service to the society.

Zay Jeffries

Nominated Treasurer of the Society

BORN at Willow Lake, South Dakota, April 22, 1888, he was graduated from the South Dakota State School of Mines, Rapid City, South Dakota, in 1910 with the degree of Bachelor of Science in Mining Engineering. In 1914 he received the degree of Mining Engineer at the same school. Between the years 1911 and 1916 he was instructor in metallurgy at Case School of Applied Science, Cleveland, and in 1916 and 1917 was appointed Assistant Professor of Metallurgy at the same school.

At the present time Dr. Jeffries is in charge of the Cleveland Section of the Research Bureau of the Aluminum Company of America and is consulting metallurgist for the National Lamp Works of the General Electric Co.

In recognition of the valuable services rendered to the Society during the past two years, during which time Dr. Jeffries has been national treasurer, the committee again nominated him for the office of treasurer.

Robert G. Guthrie

Nominated for Director for Two Years

ROBERT G. GUTHRIE of Chicago, is chief metallurgist of the People's Gas Light and Coke Company and past and present chairman of the Chicago Chapter, A. S. S. T.

Mr. Guthrie specializes in high power metallography which he applies in his research work for the many industrial consumers of gas in the Chicago district. He holds the world's record for high power magnification at 15,500 diameters of lamellar pearlite. He has made many contributions to professional journals, his latest having been almost entirely in the field of metallography.

Mr. Guthrie is 34 years old. He has been engaged in mining and metallurgy of iron and steel since the beginning of his career.

Hyman Bornstein

Nominated for Director for Two Years

HYMAN BORNSTEIN was born in Chicago, Illinois, September 3, 1891. Attended Armour Institute of Technology, 1907-1911, receiving degree of B. S. in Chemical Engineering. Attended John Marshall Law School, 1912-1915, receiving degree of LL. B.

Chemist, Union Pacific R. R., 1911; chemist, Swift and Company, 1912; engineering chemist, City of Chicago, 1913-1917; U. S. Army, 1917-1919, captain, Ordnance Department; chief chemist and metallurgist, Deere and Company, Moline, Ill., 1920 to date.

Member American Chemical Society, American Institute of Mining and Metallurgical Engineers, American Society for Steel Treating, American Society for Testing Materials, Quad-City Foundrymen's Association. Chairman, Tri-City Chapter A. S. S. T., 1923-24. Chairman, Tri-City Technical Council, 1923 to date.

SOME TRADE PRESS COMMENTS ON THE CONVENTION AND EXPOSITION

IN a ten-page review of the activities of the Seventh Annual Convention and Exposition of the American Society for Steel Treating held in Cleveland, September 14 to 18, the *Iron Age* of September 24, 1925, says in part, that—

"Both technically and as an exhibition the annual gathering of American steel treaters this year set a new mark. It has definitely become one of the leading events in the year's history of the steel industry—eagerly looked forward to by metallurgists, steel treaters and steel equipment makers. All past records were easily eclipsed in the quality of the program, in the attendance of leading metallurgists, steel men, and others, in the size and success of the exposition of the American Society for Steel Treating which met in Cleveland last week, September 14 to 18. Praise and admiration for the smoothness with which this really large undertaking passed off was heard on all sides.

"Registration of members, exhibitors and guests is officially reported as 5420. Of these 1912 were members, which is about 58 per cent of the total membership—a new record. At Boston last year 1210 members were present, or 40 per cent of the total.

"From a technical standpoint the convention was one of the highest in quality ever conducted by steel men in this country. The ten sessions, held mornings and afternoon each day in the ball rooms at the Hotel Cleveland and the Hollenden Hotel, respectively, were distinguished by an unusually large attendance and a keen interest in each session, even up to the last one. Sel-

dom did the number present fall below 250 and at one session the attendance was at least 500. Men of prominence occupied the chair at each session and leading metallurgists read papers or participated in the discussions. For the first time preprints of the papers were available for distribution, some of them having been distributed earlier by mail. By the time the sessions were opened about 75 per cent were in printed form."

Iron Trade Review

In an extended survey of the exposition and convention of the society, the *Iron Trade Review* of September 24, 1925, makes the following comments:

"With a registration of approximately 5000 and a total attendance of over 40,000 at the steel exposition at Cleveland last week, September 14-18, the American Society for Steel Treating added another successful convention to its record of achievements. Both the convention and exhibition were unusually satisfactory, particularly the latter, for never before has the society had the opportunity to conduct the exposition in a hall possessing facilities equal to those of the Cleveland Public Auditorium. These facilities, as well as the fact that the Auditorium is within walking distance of the convention hotels, had much to do with the success attained. Attendance at this show appeared to be of a considerably more interested character than previously. Some 15 foreign countries were represented at the convention, this signifying that export trade is being investigated. Exhibitors, particularly those showing machine tools, report many orders received.

"Technical sessions were well attended and more efficiently handled than ever before, resulting in more and better discussion. The Society of Automotive Engineers held a production meeting in Cleveland the first three days of the week, an arrangement which proved advantageous to both societies.

"Those who attended the meetings and exposition of the American Society for Steel Treating at Cleveland last week undoubtedly were impressed with the size and importance this annual event has attained in the brief seven years of the society's existence. To experienced eyes there was not a thing in evidence at the meeting that would not have done credit to an organization

many years older. This amazing rise to maturity is due first to the patent need of a technical society in the field of steel finishing, and second to the able direction of the business affairs of the organization.

"What of the future? The society now embraces the entire field from the making of steel to its ultimate use in fabrication. To serve the manifold technical needs and demands of the scores of groups in this wide section of industry is a task far more difficult than that ever attempted by any national organization of this type. It calls for painstaking attention to the needs of the individual, and for machinery for administering this attention effectively to thousands.

"The A. S. S. T. owes much of its present strength to its firm grip on its members, doubtless resulting from local chapter contact. The work at hand, therefore, is to enlarge the circle, but without losing the power of this individual contact.

"From its past success, the society may be expected to do its full duty in accomplishing this new feat of expansion. The divisions of industry embraced by the society's broader scope of activity are fortunate in having a new clearing house for technical ideas. Industry needs the A. S. S. T., which in turn, seems alert to grasp the opportunity."

American Machinist

The *American Machinist* in its September 24, 1925, issue devotes four of its pages to a review of the exposition and convention of the society during the week of September 14, 1925. Sketches from this review are as follows:

"Again the American Society for Steel Treating has broken its records for successful expositions. At the seventh annual exposition, held in the Cleveland Public Auditorium, September 14 to 18, inclusive, the entire available space was taken up by 180 exhibitors. Seventy-five machine tool builders had machines in operation, many of them on production work. It is estimated that the value of the exhibits was $2,000,000. It is reported that many sales were made, some of them during the first day.

"To say that an exposition is the greatest of its kind ever held is a sweeping statement. Nevertheless, it is a statement that was made by many of the exhibitors, some of whom have been show-

General View of the Exposition (Arena Floor) as Seen from the Balcony

ing their equipment in expositions for many years. Certain it is that the steel show was a great success from the viewpoint of the dissemination of information on modern equipment. The entire exposition pointed out, to the man who will observe, the futility of attempting to compete in the production world, without replacing his obsolete equipment.

"There were approximately 5,000 registrations, which included the names of members of the society, their guests and exhibitors. An accurate count of all visitors entering the doors is almost impossible. Many individuals will, of course, pay several visits. A careful estimate places the total attendance at between 40,000 and 45,000.

"The technical sessions of the convention maintained the high standard set at previous conventions. The members of the society are hard workers. They deal with highly technical subjects and the preparation of papers requires an enormous amount of work. The length of the program and the nature of the papers, the titles of which are given elsewhere in this report, indicate that effort was not spared in this year's work."

THE ANNUAL CONVENTION

TO state that the Seventh Annual Convention and Exposition of the American Society for Steel Treating held in Cleveland the week of September the 14th, was highly successful would be stating the case mildly. It was a success from every standpoint. The attendance at the huge exposition which occupied the entire exhibition space on both floors and stage of the huge Cleveland Public Auditorium has been estimated at 45,000. The registration of members and guests was in excess of 5,000, there being 1912 members among this number. This large registration of members represents about 58 per cent of the total membership of the society. This figure establishes a new record.

From the standpoint of the quality and number of exhibits at the exposition, the high quality of technical and practical papers presented at the technical sessions, and the unprecedented attendance of members and guests, mark this convention as unequalled by all previous ones.

More than 180 different firms exhibited their products. Of this number more than 75 machine tool builders had their ma-

CHAIRMEN OF CLEVELAND CONVENTION COMMITTEE

E. C. SMITH
Meetings and Papers

W. C. BELL
Finance

W. F. ABEL
Men's Entertainment

H. M. BOYLSTON
Ladies' Entertainment

COL. J. B. DILLARD
General Chairman

W. H. WHITE
Hotels

G. I. ALLEN
Plant Inspection

J. V. EMMONS
Information

A. H. FRAUENTHAL
Transportation

chines in operation in the Exhibition Hall on production work. The entire exhibition occupied more than 40,000 square feet of floor space, which was the entire available space at the Cleveland Public Auditorium. The exposition was open each day from 1:00 P. M. to 10:00 P. M., with the exception of Thursday. On Thursday the exposition opened at 10:00 A. M. and closed at 5:30 P. M. on account of the annual banquet which was held in the evening.

For confirmation that the technical sessions were of an unusually high order we need only to refer to those who were in attendance at any or all of these sessions, or to refer to the statements made by a number of the trade publications as published on the preceding pages of this issue of TRANSACTIONS.

For those who were unable to attend this convention the following outline will give a brief account of the activities during the week.

The morning technical sessions were held in the Ball Room of the Hotel Cleveland, while the afternoon technical sessions were held in the Ball Room of the Hotel Hollenden.

MONDAY, SEPTEMBER 14

The first technical session was held in the Ball Room of the Hotel Cleveland at 10:00 A. M., Monday morning, September 14. This session was opened by an address of welcome by H. A. Schwartz, chairman of the Cleveland chapter of the society and chairman of this session. Following Mr. Schwartz, Colonel J. B. Dillard, general chairman of the Cleveland Convention committees gave an address of welcome on behalf of his committees. This address of welcome was responded to by President W. S. Bidle.

Following these speeches the meeting proceeded with its technical program, the following papers being presented:

10:15 A. M.—***Interpretation of Notched Bar Impact Test Results***—Paul Heymans, Massachusetts Institute of Technology, Cambridge, Mass.

10:50 A. M.—***Chemical Composition of Tool Steels***—J. P. Gill and M. A. Frost, Vanadium Alloys Steel Co., Latrobe, Pa.

11:25 A. M.—***Experiments with Nickel, Tantalum, Cobalt and Molybdenum in High Speed Steels***—H. J. French and T. G. Digges, Bureau of Standards, Washington, D. C.

The first paper by Paul Heymans was presented by T. H. Frost of Massachusetts Institute of Technology. The second paper was presented by J. P. Gill and the third by H. J. French. Considerable discussion followed each of these papers, some of which had been prepared in writing.

The second technical session was held at 2:00 P. M., in the Ball Room of the Hotel Hollenden, with Dr. A. E. White presiding.

Three papers were scheduled for this session and are as follows:

2:00 P. M.—*Effect of Cold Work on Endurance and Other Properties of Metals*—D. J. McAdam, Jr., U. S. Naval Engineering Experiment Station, Annapolis, Md.

2:40 P. M.—*Graphitization at Constant Temperature*—H. A. Schwartz, National Malleable & Steel Castings Co., Cleveland.

3:20 P. M.—*Some Factors Affecting Coercive Force and Residual Induction of Some Magnet Steels*—J. R. Adams and F. E. Goeckler, Midvale Co., Nicetown, Philadelphia.

Each of these papers were presented by their respective authors. J. R. Adams presented the third paper, of which he was joint author with F. E. Goeckler.

As was the case with the morning technical session, considerable discussion followed the presentation of each of these papers.

Tuesday, September 15

The morning technical session was called to order at 9:30 A. M. by the chairman, Dr. J. A. Mathews. This session had to do with problems in the manufacture of steel by both the open hearth and the electric furnace processes. Four papers were scheduled for this session and are as follows:

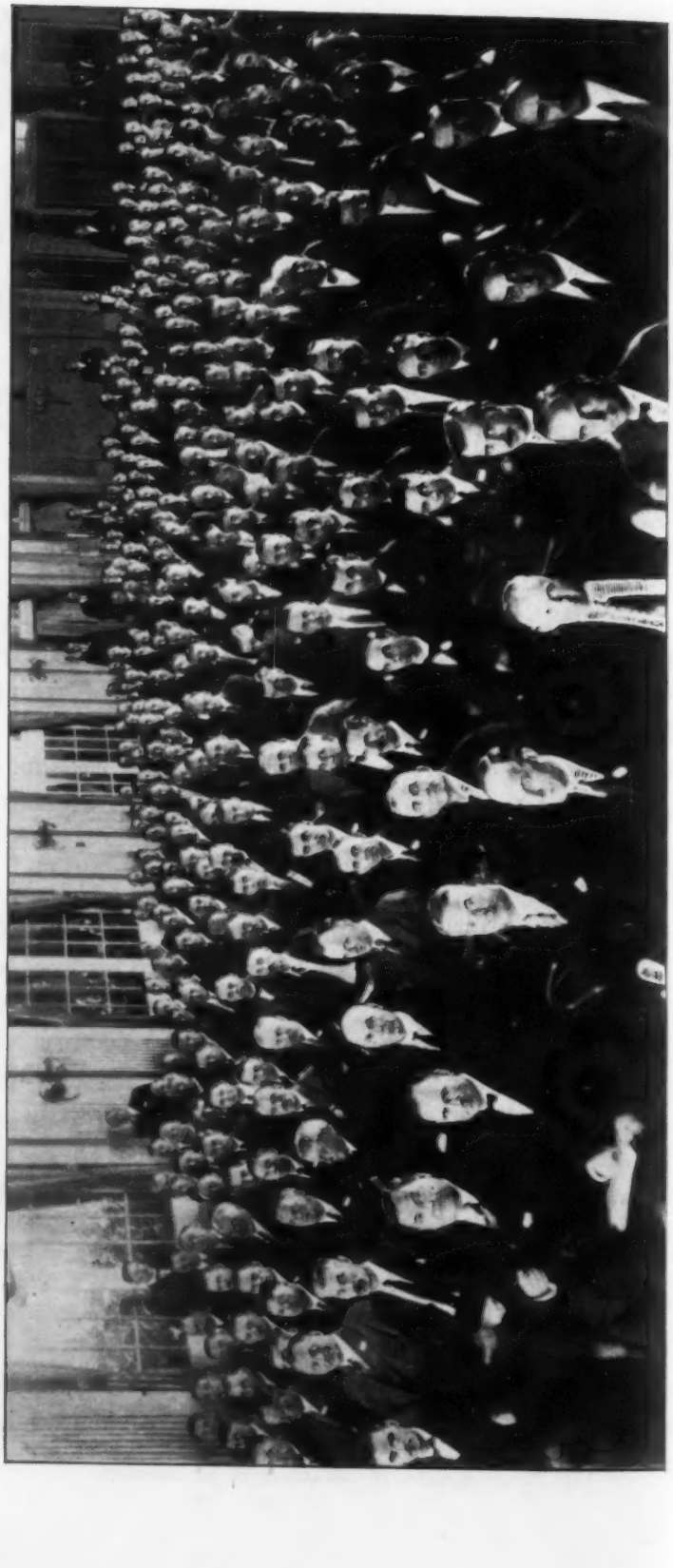
9:30 A. M.—*Proportion of Heat Treated Steel to Total Production*—C. J. Stark, Iron Trade Review, Cleveland.

9:50 A. M.—*Acid Open Hearth Steel*—Radclyffe Furness, Midvale Co., Nicetown, Philadelphia.

10:30 A. M.—*Basic Open Hearth Steel*—E. A. Whitworth, Gathmann Engineering Co., Baltimore.

11:15 A. M.—*Electric Furnace Steel*—F. T. Sisco, McCook Field, Dayton, Ohio.

Each of these papers was presented by the respective author, with the exception of Mr. Sisco's, which was presented in abstract by Jerome Strauss.



More Than 500 Were in Attendance at the Steel Melting Session, Tuesday Morning, September 15

This session was very well attended as will be observed in the photograph on the opposite page, which was taken during the session. This session marks the first effort of the society in the discussion of the problems entering into the production of steel.

At 12:30 P. M. the Metallurgical Education Symposium Luncheon was served to about 75 members and guests at the Hotel Cleveland. Dr. A. E. White was chairman. One of the main points which was stressed was the need for a more rigid instruction of the fundamentals.

The afternoon technical session was held in the Ball Room of the Hollenden Hotel at 2:00 P. M., Dr. Zay Jeffries being the chairman of the session: Three papers were scheduled for this meeting as follows:

2:00 P. M.—*Comparative Slow-Bend and Impact Notched Bar Tests on Some Metals*—S. N. Petrenko, Bureau of Standards, Washington, D. C.

2:40 P. M.—*Effect of Reheating on Cold Drawn Bars*—S. C. Spalding, Halcomb Steel Co., Syracuse, N. Y.

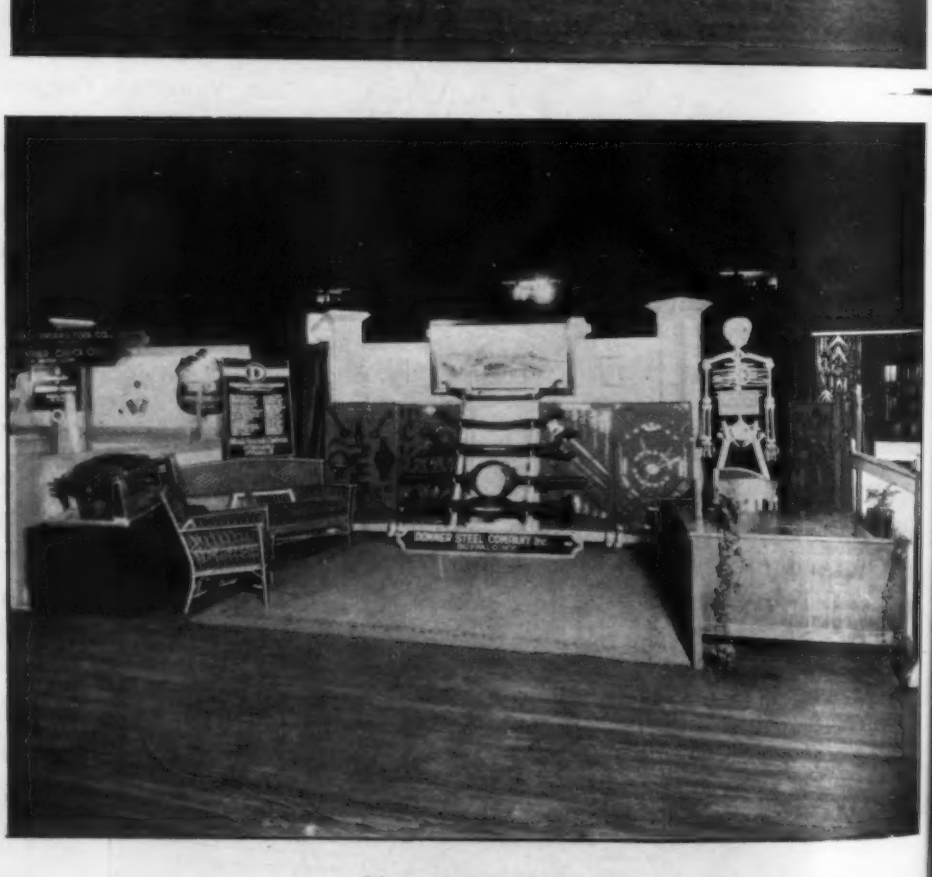
3:20 P. M.—*Application of the Mathematics of Probability to Experimental Data as a Basis for Appropriate Choice of Ferrous Materials*—B. D. Saklatwalla and H. T. Chandler, Vanadium Corporation of America, Bridgeville, Pa.

Each of these papers was presented by the respective authors and in the case of the third paper, H. T. Chandler presented the paper of which he was author with Dr. B. D. Saklatwalla. An interesting discussion followed each paper.

The Annual Smoker

The annual smoker and entertainment was held in Gray's Armory on Tuesday evening at 10:00 P. M. This entertainment is looked forward to by every member of the A. S. S. T. and the program which was arranged by W. F. Abel proved to be one of the best programs that has ever been arranged for the society. There were many high grade vaudeville stunts and features on this bill.

One of the outstanding features of the program was a minstrel show put on by members of the New York chapter of the society. These men, under the direction of E. P. Gaffney, deserve much credit for their very commendable efforts in entertaining those in attendance at the smoker.



Views of the Exposition

WEDNESDAY, SEPTEMBER 16

The annual meeting of the members of the American Society for Steel Treating was held in the Ball Room of the Hotel Cleveland at 9:30 A. M. This meeting was presided over by President W. S. Bidle, who at the outset delivered his annual address. Following Mr. Bidle, W. H. Eisenman, national secretary of the society, read his annual report. Immediately following this report the national treasurer, Dr. Zay Jeffries, read his annual report. These reports are printed in full as follows:

THE PRESIDENT'S ANNUAL ADDRESS

Presented by WILLIAM SANFORD BIDLE, *President, 1925*

READING from the Constitution, Article XI, Section 5a,—the duties of the president: "He shall at the annual meeting, on behalf of himself and on behalf of the Board of Directors, make an annual report to the members of the business and affairs of the Society."

With the change in the Constitution that went into effect last year, your present Board of Directors took office January 1, 1925, and will continue to the end of the year. Any report therefore, at the present time, must, of necessity, be only a partial one for the calendar year and an attempt to acquaint you with the general activities of the Society.

Your secretary will as usual make a most complete report of the accomplishments of the Society, and your treasurer has a very gratifying financial report for you.

For some time past, as you know, the full minutes of all Directors' meetings have been published in TRANSACTIONS, which is a most unusual proceeding for a national Society. This, coupled with the publishing quarterly of a financial statement, keeps the members very well acquainted with the "business and affairs of the Society" so that, frankly, your president feels that any report from him should be very brief.

In analyzing the phenomenal success of your Society which with this convention celebrates its fifth anniversary—and phenomenal is the only word that can be used for one so young—one reason is undoubtedly due to the foresight of the founders in making the chapter and its meetings of first and paramount im-

portance. In other words, the Society is only as strong as its individual chapters.

In order to obtain first hand information as to what is desired by the chapters and to invite constructive criticism of the national organization from the members, your secretary and president have met with and visited nineteen of the chapters. We intend to visit eight additional chapters before the end of the year. It has been our most ardent and sincere wish, and that of your Board of Directors, to serve you and your chapters to the best of our ability.

Another reason for this phenomenal success has of course been due to the fact that we had a real message, a field peculiarly our own, and gradually, we have intensively cultivated that field and delivered our message, until today, our Society is deservingly receiving the recognition which is its due.

A society's growth from year to year is directly dependent on its services to its members. Under your former officers, all society activities had been so well organized as to leave but little that your present ones might initiate. The increase in the volume and character of our publications, the productive results of our national committees, the preprinting of convention papers, and the increased size and scope of our exhibition, may well be taken as our contribution to this service for our members.

All of our chapters are in a very healthy condition and inasmuch as we consider the chapter, in the final analysis, the keystone to our success, our appreciation must be expressed to the chairmen, secretaries and executive committees of the various chapters for their conscientious work. Each and every one of our national committees has functioned faithfully and well, and in this connection, it is especially pleasing to note that with the many changes and additions made to these in the present year, there was not one refusal from any member requested to serve.

Our thanks are due to our advertisers and exhibitors for their co-operation in the successful work of the Society.

It has been your president's privilege now to serve on the Board of Directors for four years and he can honestly state that he has never been associated with so many men who have so earnestly and conscientiously taken their duties to heart.

In conclusion, your president wishes to express his most sincere appreciation of the honor which you conferred upon him,

and takes this occasion to thank the members of the various chapters that he has visited for the painstaking efforts put forth to make his stay both pleasant and profitable.

ANNUAL REPORT OF THE SECRETARY

Presented by WILLIAM HUNT EISENMAN, *Secretary*

ON August 31, 1925, the American Society for Steel Treating had a total of 3,363 members. Of this number 2,452, or 73 per cent were of member classification; 500, or 14.85 per cent of associate member classification; 243, or 7.22 per cent of sustaining member classification; while 160, or 4.75 per cent were of junior

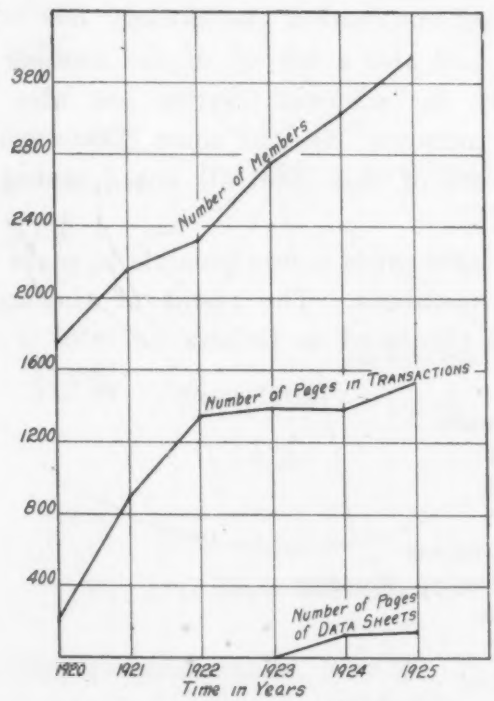


Fig. 1—Showing Increase in Membership, Transactions and Data Sheets.

membership classification. The Society has 6 honorary and 12 founder members.

The membership of the Society on August 31, 1924, was 3,062. The net increase in members in the past year has been a total of 337, a gain of 11.0 per cent.

The chart (Fig. 1) shows the gain in members from 1920,

the date of the organization of the Society, to the present time. This growth is a very steady and healthy one and represents what has come to be considered the normal growth of the Society during any particular year. No stimulants have been offered to induce membership, but all members have been obtained through invitation on the part of those who are already members of the Society and recognize its benefits.

At the Boston convention, September 25, 1924, Professor Kotaro Honda, of the Imperial University of Sendai, Japan, was elected to honorary membership in the Society and was present in person to accept.

We regret to announce the death of one of our honorary members,—Elwood Haynes.

Since the last convention the Society has made an analysis of its members, and also a survey of the number of readers who observe not only the editorial matter but also the advertising matter in TRANSACTIONS. Out of some 3000 cards sent out 2000 were returned, and of this 2000 all but 4 stated that they read the advertising.

From these 2000 cards it was possible to make an occupational analysis of our members. The result of the analysis is shown in Fig. 2 and is tabulated as follows:

	Per Cent
Metallurgists	20
Salesmen	12
Engineers	11
Managers	10
Superintendents	10
Heat Treating Foremen	10
Presidents	4
Chemists	4
Proprietors	3
Instructors and Students	3
Vice-presidents	2½
Miscellaneous	10½
	100

Chapters

The 29 chapters of the Society are in a healthy condition and the membership standing of the chapters is published each

month in the news of the chapters, in TRANSACTIONS.. The chapters have held a total of 224 meetings during the year with an attendance in the neighborhood of 25,000, the programs prepared being of outstanding merit and reflecting much credit upon the chapter program committees.

Two fine sectional meetings have been held,—the Winter Sectional Meeting at Cincinnati, January 15 and 16, and the Spring

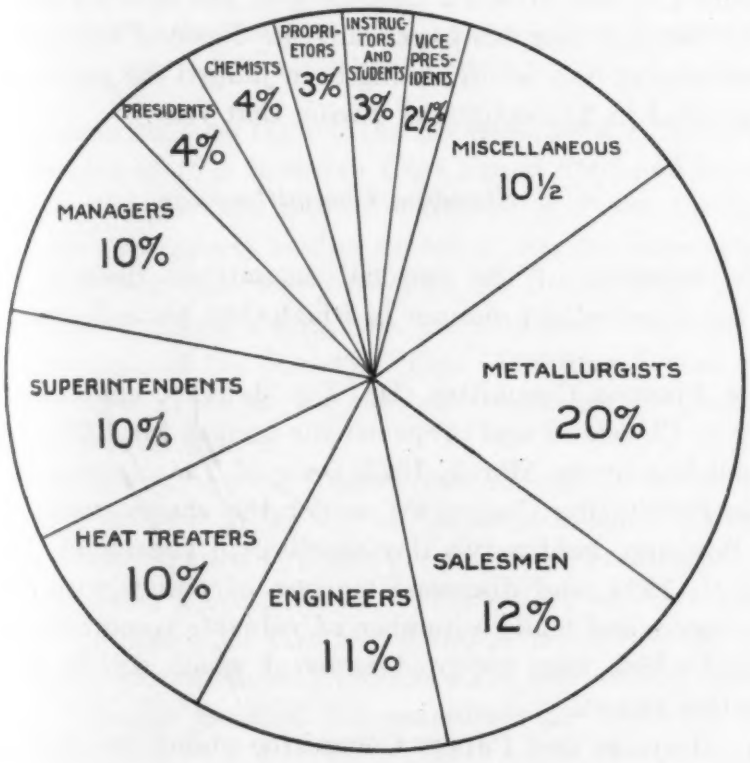


Fig. 2—Analysis of Membership (1925)

Sectional Meeting at Schenectady, May 28, 29 and 30. The meetings were well attended and very profitable and the membership of the two local chapters gained great credit for themselves by the remarkable organization and results attained at these meetings.

The financial condition of the chapters is very satisfactory. According to reports of the treasurers submitted at the end of the chapters' fiscal year there was a total of $12,887.37 in the chapter treasuries, the largest amount in any one chapter being $2,454.72.

The 1925 budget estimates the return to local chapters of $14,800.00 of the dues collected.

Henry Marion Howe Medal

The Henry Marion Howe Medal, established by the Society in 1922 in memory of our late honorary member, Doctor Henry Marion Howe, was awarded in 1922 to Emanuel Janitzky of Chicago. In 1923 no award was made. However, in 1924 Francis F. Lucas, a member of the New York chapter, and research engineer in the Bell System laboratories of the American Telephone & Telegraph Co., and Western Electric Co., was selected as the Howe Medalist for that year, his paper on *High Power Photomicrography of Metallurgical Specimens* having been judged the paper of highest merit printed in TRANSACTIONS during that year.

Standing Committees

The members of the national committees deserve unstinted praise for the excellent manner in which they have discharged their duties.

The Finance Committee, Dr. Zay Jeffries, chairman, held a meeting in Cleveland and prepared the budget for 1925, the report was published in the March, 1925, issue of TRANSACTIONS.

The Publication Committee, under the chairmanship of Prof. H. M. Boylston, held a two day meeting in Cleveland, November 20 and 21, 1924, and discussed matters of policy with regard to TRANSACTIONS and made a number of valuable recommendations to the Board which were accepted, some of which will be dealt with later in this report.

The Meetings and Papers Committee under the chairmanship of E. C. Smith, has done an exceptionally fine piece of work in the preparation of the program for this 1925 convention. Some 28 papers, exclusive of those for the Hardness Testing Symposium, are to be presented this week, the papers being of very high grade and deserving great praise.

The Constitution and By Laws Committee has been inactive due to the fact that no matters of importance came up during the year requiring its attention.

It is interesting to note the commendable work that has been done by the Recommended Practice Committee under the direction of J. Fletcher Harper. This committee held two meetings during the year when they passed upon proposed recommended practices

as well as the selection of subjects for data sheets. The sub-committee on Tool Steel, with W. J. Merten as chairman, has produced good results and during the last year has compiled tentative recommended practices on the following subjects:

1. Recommended Practice for the Heat Treatment of Non-shrinking, Non-deforming, Oil hardening Tool Steels.
2. Recommended Practice for the Heat Treatment of Finishing Steels.
3. Recommended Practice for the Heat Treatment of Taps and Milling Cutters.

This committee also revised the *Recommended Practice for the Heat Treatment of 18% tungsten High Speed Steel* and the *Recommended Practice for the Heat Treatment of Plain Carbon Tool Steel.* These two reports having served a year for observation and criticism have been finally approved by the Board of Directors and Recommended Practice Committee, and are now standard recommended practices of the Society. This committee is now working on recommended practices for the heat treatment of plain carbon and alloy steel die blocks.

The sub-committee on Heat Treatment of Plain Carbon and Alloy Spring Steels with W. H. Phillips as chairman, has prepared a *Tentative Recommended Practice for the Heat Treatment of Plain Carbon and Alloy Spring Steels.* This report has been published in TRANSACTIONS and the HANDBOOK and is now before the members as a tentative recommended practice. The Recommended Practice Committee recently assigned this committee the following problems for report:

1. Methods of Heating and Forming Springs.
2. Data for Figuring Stresses.

The sub-committee on Measuring Case Depth, under the direction of S. P. Rockwell, has work in process but has not as yet had opportunity to complete its report.

The sub-committee on Carburizing Gears, F. C. Raab, chairman, held two meetings during the year and completed their report on the heat treatment and carburizing of gears. This report has been approved by the Recommended Practice Committee and is awaiting distribution.

The sub-committee on Carburizing Cam Shafts, E. H. Stilwill,

chairman, held two meetings during the year and completed a report on heat treatment and carburizing of cam shafts which is now in the hands of the Recommended Practice Committee.

The Committee on Hardness Testing of Metals is a new one with the Society. This committee formerly functioned under the supervision of the National Research Council, Major A. E. Bellis, chairman.

During the time of this committee's connection with the National Research Council, it used the facilities of the annual conventions of the A. S. S. T. for the presentation of their reports which were then published in TRANSACTIONS. Having completed the work assigned by the Council, this committee naturally found a welcome home among the committees of the A. S. S. T. The committee with Major Bellis continuing as chairman, will present a symposium on Thursday of this week. The great interest aroused by this committee is shown by the number and quality of papers to be presented and is indicative of the great amount of material this committee can correlate and present for the benefit of the Society.

Cooperative Committees

The Society has continued representation in cooperation with other agencies and societies in the following:

National Research Council, Division of Engineering	A. E. White
War Department, U. S. A.	H. J. French
Advisory, Bureau of Standards	T. D. Lynch, A. E. White
Bureau of Mines, Drill Steel Investigation	H. S. Brainerd
On Nomenclature with A. S. T. M. and S. A. E.	J. E. Halbing
Sub Committee XIV on Tool Steels of Comm. A. 1, A. S. T. M.	W. M. Mitchell
American Society of Mechanical Engineers, Committee on Research in the Machine Tool Industry	H. J. French, Frank Garrett
Sectional Committee on Steel Specification Numbers, S. A. E., A. S. T. M.	A. P. Spooner
Research Committee on Springs, A. S. M. E.	J. W. Rockefeller, Jr.
Sectional Committee on Specifications for Zinc Coating of Iron and Steel, A. S. T. M., A. E. S. C.	H. M. Boylston

In summarizing the work of the committees of the A. S. S. T. it is noted with pleasure the rapid progress made since J. Edward Donnellan assumed his duties at national headquarters. Mr. Donnellan acts as secretary of all of the national committees in the

collection of data and information so that the committees as a rule act as a court of final decision upon the subjects considered. The thanks of the Society are due and cheerfully given to those members of the organization who are so willingly giving of their time and talents to the work of the national and local committees.

TRANSACTIONS

Observations of the chart (Fig. 1) will show the number of pages of editorial matter published by the Society in TRANSACTIONS since its organization in 1920, altogether a total of 6,746 pages, divided into 8 volumes (the eighth volume not yet complete).

In 1925, estimating the pages to be published in the next three issues of TRANSACTIONS, there will be a total of 1,532 pages issued. TRANSACTIONS has made commendable progress under the direction of Ray T. Bayless, editor, and is constantly receiving increasing favorable comment.

Beginning with February, 1925, on the recommendation of the Publication Committee, a section of TRANSACTIONS of at least 32 pages each issue is now devoted to the publishing of articles of practical interest which includes write-ups of plants and papers on educational subjects dealing with the fundamentals of metallurgy. This section is meeting with a cordial reception among the members both practical and theoretical. The size of TRANSACTIONS was increased 32 pages per issue, so that there would be no diminution whatever in the amount of material published of a research character.

Another decided improvement in TRANSACTIONS is the Chapter News Section, containing write-ups, by an official representative of the chapter, of papers presented before the chapters. Thus, many valuable points brought out in papers before local chapters,—papers not submitted for publication, are presented to the members.

Preprinting Papers

For some time there has been a feeling among the members of the A. S. S. T. that the Society had reached such a position of prominence and financial condition that it would be advisable to prepare preprints of as many of the annual convention papers as possible. With this in mind, the Board of Directors at their Jan-

uary meeting authorized the preparation of these preprints, and some 20 of this year's convention papers have been preprinted and sent out to members of the Society requesting them.

Numerous invitations were sent out by President Bidle for written discussion on these papers. The response has been so very satisfactory that at this meeting there will undoubtedly be presented a larger number of written discussions than have ever before been presented at an annual meeting.

The cost of the preprinting of these papers has been about $1,500.00. Economy was effected inasmuch as the type can readily be used when published later in TRANSACTIONS combined with the discussions at the meeting.

DATA SHEETS

As previously stated, the work of the preparation of data sheets under the direction of the Recommended Practice Committee, has progressed very favorably since the last annual report of the Secretary, when 116 pages of data sheets were reported as being in the hands of the members, this number covering some 17 different subjects.

Since that report the following data sheets have been issued:

18.	*Temperature Conversion Data*	2 pages
19.	*Mass Influence in Heat Treatment*	4 pages
20.	*Interconversion Table for Units of Energy*	1 page
21.	*Interconversion Tables for Units of Volume and Weights*	1 page
22.	*Nickel and Nickel-Chromium Steels*	22 pages
23.	*Stainless Steel*	8 pages
24.	*Vanadium as an Alloying Element in Steel*	6 pages
25.	*Recommended Practice for the Heat Treatment of Non-shrinking, Non-deforming, Oil-hardening Tool Steels*	2 pages
26.	*Recommended Practice for the Heat Treatment of Finishing Steels*	2 pages
27.	*Recommended Practice for Heat Treatment of Taps and Milling Cutters*	4 pages
28.	*Tool Steel Trade Names*	10 pages
29.	*Photomicrography*	16 pages
30.	*Critical Illumination in Photomicrography*	4 pages
31.	*S. A. E. Steel Specifications*	4 pages
32.	*Rockwell Hardness Tests*	3 pages
33.	*Scleroscope Hardness Tests*	4 pages
34.	*Percentage Reduction of Area of Tensile Test Specimens*	6 pages
35.	*Test Specimens*	13 pages

36.	*Fuel Consumption and Heat Losses*	6 pages
37.	*Recommended Practice for Heat Treatment of Plain Carbon and Alloy Spring Steels*	2 pages
38.	*Heat Treatment of Permanent Magnet Steels*	4 pages
		124 pages

Revised Data Sheets Issued

8. *Recommended Practice for the Heat Treatment of 18% Tungsten High Speed Steel (A. S. S. T. Standard).*
9. *Recommended Practice for the Heat Treatment of Plain Carbon Tool Steel (A. S. S. T. Standard.)*
13. *Brinell Hardness Tests (enlarged from 2 to 5 pages).*

Data Sheets Printed But Not Yet Distributed to Membership

1. *Corrosion of Iron and Steel.*
2. *Abrasive Wheels for Grinding Wheels.*

Data Sheets Approved by Recommended Practice Committee for Publication

1 *Carburizing and Heat Treatment of Carburized Steel.*
2. *Non-Ferrous Etching Reagents*
3. *Physical Constants for Alloy-forming elements.*

Data Sheets Prepared But Now Being Revised and Reviewed

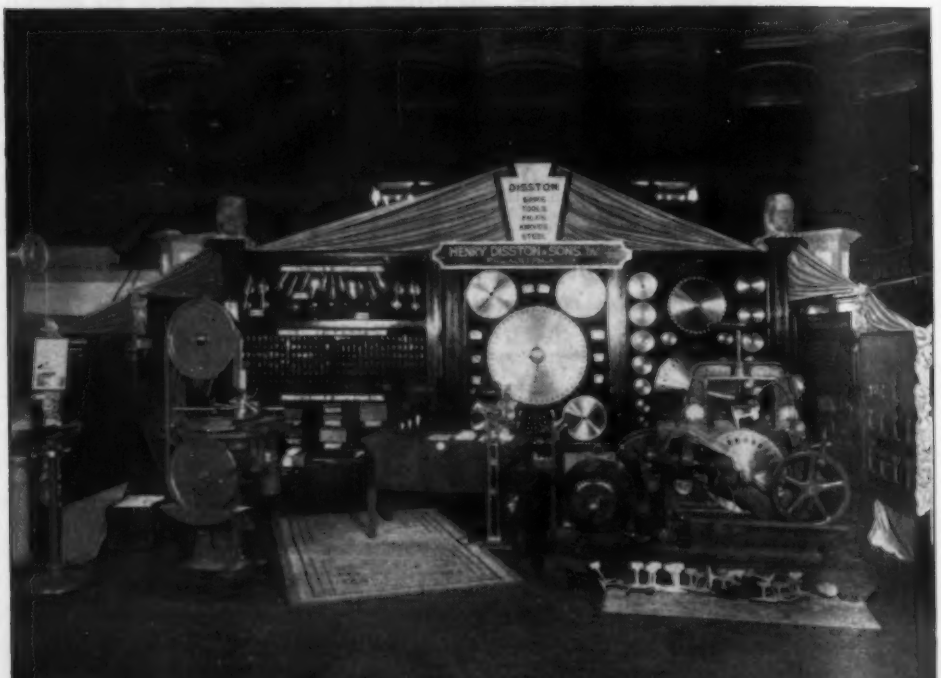
1. *Stellite*
2. *Manganese as an Alloying Element in Steel*
3. *Furnace Efficiencies (electric)*
4. *Magnification Charts for Metallographic Microscope*
5. *Ferro Alloys Used in the Manufacture of Steel*
6. *Chromium as an Alloying Element*
7. *Fundamentals of Electric Heating*

About 14 other subjects are now in preparation by the authors.

During the year there were prepared and issued 135 pages covering 24 subjects. The HANDBOOK at the present time contains 243 pages on 38 subjects.

EXPOSITION

It is needless to state that the A. S. S. T. expositions have been



Views of the Exposition

making progress from year to year, growing not only in size and number of exhibitors, but also in the number in attendance.

While at Boston, attendance was somewhat less than at Pittsburgh, this was due to a different method of distribution of tickets by exhibitors, which resulted in bringing in a more interested

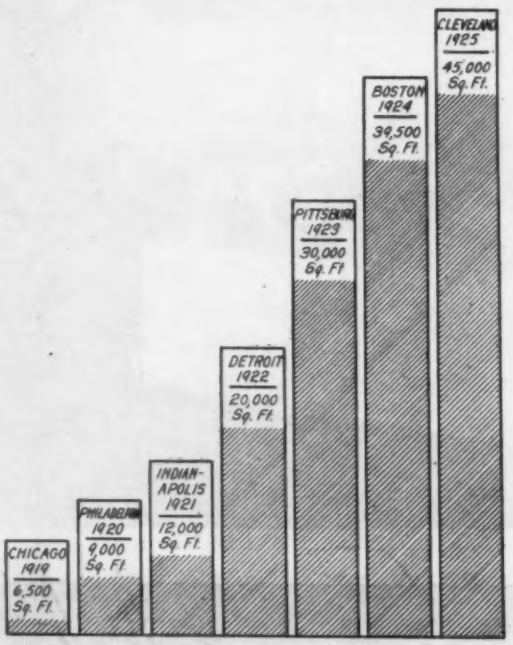


Fig. 3—Graph Showing the Amount of Exhibition Space Used at Each of the Seven Conventions of the Society.

group of individuals to view the exhibition, thus eliminating the sight-seers and souvenir hunters.

The chart (Fig. 3) shows the growth of the expositions since the first one in Chicago.

The nature of the exhibits has changed somewhat from the first exposition when only heat treating supplies were shown until now it includes a complete cycle of the steel industry from the raw material to the finished product, including steel in its raw form as shown by the steel companies, the machine tool section, where it is fabricated, the heat treating section, where the physical properties are brought out, and finally the inspection. This exhibition typifying as it does, the complete cycle of the industry, has been doubly beneficial to all exhibitors, as well as those in attendance due to the fact that there an individual may see all departments in which he is interested and he is thus encouraged to attend a convention where he is sure to find his major interest amply satisfied.

Views of the Exposition

The exposition next year will be held in Chicago on Municipal Pier. This building offers exceptional facilities for exhibit purposes, being 67 feet wide and 2360 feet long. There it is hoped to be able to accommodate all those desiring to exhibit, and that it will not be necessary, as it has been this year, to refuse the requests of some 70 firms because of inadequate facilities.

ANNUAL REPORT OF THE TREASURER

Presented by ZAY JEFFRIES, *Treasurer*

AN unaudited profit and loss statement of the American Society for Steel Treating from January 1 to August 31, 1925, inclusive, and the balance sheet as of August 31, 1925, show that the financial condition of the Society continues to improve in a very satisfactory manner.

The income of the Society for the first eight months of 1925 was $49,041.45 and expenses were $46,727.37, leaving an excess of income over expense of $2,314.08. These figures are exclusive of convention income and expense. The assets as of August 31, 1925, after deducting advance receipts for the Cleveland convention were $64,430.73.

The balance sheet shows the following:

Cash Accounts:		
Commercial Account—Cleveland Trust Co.		$15,575.89
Savings Account—Cleveland Trust Co.		10,198.12
Savings Account—Equity Savings and Loan Co.		21,885.20
Savings Account—Union Trust Co.		1,148.66
Bond Investments:		
Liberty Bonds	$28,000.00	
Euclid Village Water Bonds	3,000.00	
Cleveland Trust Securities		
5½% Collateral Trust Bonds	10,000.00	41,000.00
United States Treasury Certificates		2,165.00
Accounts Receivable		3,082.20
Inventory and Office Furniture and Fixtures		3,266.65
Prepaid Expenses for 1926 Convention		208.35
		$98,530.07
Amount to be refunded to the chapters for dues received in August		438.54
		$98,091.53

There is also included in the above cash accounts the advance receipts for the present convention	$43,470.00	
Less expenses paid to August 31st	9,809.20	
		33,660.80
As the services to be rendered for these advance receipts have not yet been completed and the majority of the convention charges have not been paid, a deduction of this amount should be made and the result will give the Society's present net worth, exclusive of the Cleveland convention profits		$64,430.75

A recapitulation of the Cleveland convention accounts showed on August 31, 1925:

Advance Receipts	$43,470.00
Expenditures to August 31st	9,809.20
Estimated Expenditures to close of fiscal year, about	20,600.00
Estimated excess of income over expense	12,000.00 to 14,000.00

The assets above referred to are entirely in the hands of the National office. In addition to these assets the local chapters have more than $12,000.00 in their treasuries.

It is expected that the financial report at the end of the present year, when the convention activities are included, will show a larger increase in the total assets of the Society than that in any previous year. While by far the greater part of the increases shown in the assets of the Society have been due to the conventions, it is significant that an excess of income over expense continues to be shown on the other activities.

It is interesting to note the average amount received from all classes of members of the Society and the cost of actual direct service rendered per member.

The present membership figures show:

2,452	Members (Annual Dues $10.00)	$24,520.00
500	Associate Members (Annual Dues $15)	7,500.00
243	Sustaining Members (Annual Dues $25)	6,075.00
160	Junior Members (Annual Dues $2.50)	400.00
8	Honorary & Founder Members (No Dues)	
Total 3,363	Members all classes	$38,495.00
	Average Dues Received $11.46	

The expenditures in direct service to members made in 1924 as taken from the audited report totaled $69,687.14.

The number of members enrolled as of December 31, 1924, was 3,174, making the service rendered per member $21.96.

Including the Cleveland convention profits the assets per member of the Society in the National Treasury of the Society are about $23.00. A new member, without payment of an initiation fee, has available for his service, depending on the particular local chapter in which he is enrolled, from $23 to $30 assets.

The following table shows the amounts paid to local chapters and the assets in the hands of the National office in previous years and for the first eight months of 1925.

Amount Paid to Chapters		*Total Assets of the A. S. S. T.*	
For 1921	$ 7,244.22	As of Dec. 31, 1921	$16,520.90
1922	10,051.95	Dec. 31, 1922	31,391.31
1923	12,751.45	Dec. 31, 1923	46,821.30
1924	14,194.14	Dec. 31, 1924	62,116.65
First 8 months of 1925	10,641.93	Aug. 31, 1925	64,430.73

It will be noted that the assets of the American Society for Steel Treating have increased during the last four years at an average rate of about $15,000 per year. Each year additional service is rendered to the members. For example, during the last two years $10,059.77 have been expended in connection with the activities of the Recommended Practice Committee largely for the preparation, printing and distribution of data sheets. The Library Service and Employment Service activities have also been materially increased. More editorial matter is being published in TRANSACTIONS. This year we have rendered especial service to a new group—our exhibitors. In commerce, prices are controlled largely by the law of supply and demand. We did not have enough space in the Cleveland Public Auditorium to go around. Between 65 and 70 requests for space were turned down. Under the circumstances, we could readily have made from $20,000 to $25,000 additional profit on the exposition. The management of the Society deserves commendation for the maintenance of the low prices for space and for giving preference to last year's exhibitors. With such treatment it is not surprising that many of the exhibitors engage space a year in advance.

It is not often that the members of an educational society have occasion to become concerned with the possibility of the accumulation of too much surplus. A number of the members have

very properly inquired regarding the financial policy of the Society. Because the president, secretary, board of directors, all of the past presidents and treasurers and your present finance committee are in entire agreement on this subject, I feel that I can advisedly act as their spokesman. The policy is to increase the service to members as rapidly as possible, consistent with the maintenance of a sound financial position. Many technical societies have suffered, some even to the point of extinction, through lack of funds. Others, notably the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Foundrymen's Association, have demonstrated that a healthy surplus is the best means of insuring continued service to members. We are not yet in a position where we need to apologize for the magnitude of our surplus. Rather it is our hope that conditions will be maintained such that the assets of the Society will continue to increase for some years to come. To do this it is only necessary to maintain our management as efficiently as it now is, and for our management to continue to enjoy the splendid support of the members.

Following the treasurer's report the next order of business was the reading of the National Nominating Committee's report of their meeting Monday, September 14, 1925. This report was read by Prof. H. M. Boylston, and is printed in full as follows:

On behalf of the Nominating Committee, I beg to submit the following report:

The Nominating Committee held its meeting on Monday, September 14, 1925, at the Hotel Cleveland, Cleveland, Ohio.

There were twenty-one (21) representatives or alternates present and H. J. Stagg was elected chairman and H. M. Boylston secretary.

Results of the ballots for officers are as follows:

For President—R. M. Bird, Philadelphia Chapter
For Vice-President—J. F. Harper, Milwaukee Chapter
For Treasurer—Zay Jeffries, Cleveland Chapter (2 years)
For Director—R. G. Guthrie, Chicago Chapter (2 years)
For Director—Hyman Bornstein, Tri-City Chapter (2 years)

All nominations were made by ballot.

In the case of treasurer, Dr. Zay Jeffries was nominated by single ballot, by the secretary, as per instructions.

I am delivering to you herewith credentials of the following representatives and alternates:

Chapter	Name	
Boston	V. O. Homerburg	Representative
Cleveland	H. M. Boylston	Representative
Chicago	T. E. Barker	Alternate
Cincinnati	E. P. Stenger	Representative
Detroit	Robert Atkinson	Representative
Hartford	L. A. Lanning	Representative
Milwaukee	H. J. Stein	Alternate
New York	A. St. John	Representative
Philadelphia	A. L. Collins	Representative
Pittsburgh	W. J. Merten	Representative
Rochester	L. Slade	Representative
Rockford	O. T. Muehlemeyer	Representative
St. Louis	Alan Jackman	Representative
Tri-City	C. H. Burgston	Representative
Washington	Jerome Strauss	Representative
Worcester	R. J. Phelon	Representative

I am also delivering herewith written acceptances of the nominations by—

R. M. Bird J. F. Harper Zay Jeffries

and telegraphic acceptance from H. Bornstein.

Respectfully submitted,

Signed: H. M. BOYLSTON, *Secretary.*

Following the announcement that the next convention of the society would be held in Chicago at the Municipal Pier, September 20 to 24, 1926, a suggestion was made that the date of our conventions be changed from the month of September to the month of October in order that better weather might be had. In answer to this suggestion President Bidle outlined some of the many factors that must be taken into consideration in selecting convention dates. He pointed out that it is necessary to select dates that do not conflict with the meeting dates of other societies and that it is not always possible to specify exactly the date that is desired in making arrangements for convention halls, but that it is often necessary to take those dates which are open.

With the close of the annual business meeting of the society Dr. G. K. Burgess took the chair and presided over the technical

session which started on the scheduled time. The papers presented at this session are as follows:

10:30 A. M.—*Retained Austenite—A Contribution to the Metallurgy of Magnetism*—Dr. J. A. Mathews, Crucible Steel Company of America, New York City.

11:15 A. M.—*On Martensite*—Dr. H. Hanemann, Technischen Hochschule, Charlottenburg, Germany. Presented by Dr. S. L. Hoyt, Research Laboratories, General Electric Co., Schenectady.

The first paper was presented by Dr. J. A. Mathews, the author, while the second paper was presented by Dr. S. L. Hoyt of the General Electric Co., Research Laboratories. Each of these papers aroused considerable discussion.

The afternoon technical session was held in the Ball Room of the Hotel Hollenden at 2:00 P. M., the chairman being E. C. Bain of the Union Carbide and Carbon Research Laboratories. The following four papers were scheduled for this session:

2:00 P. M.—*The Carbon Content of Pearlite in Iron Carbon Alloys Containing One Per Cent Silicon*—Anson Hayes and H. U. Wakefield, Iowa State College, Ames, Iowa.

2:30 P. M.—*Irregular Carburization—Its Causes and Preventions*—W. J. Merten, Westinghouse Electric & Manufacturing Co., East Pittsburgh.

3:00 P. M.—*A Study of Dendritic Structure and Crystal Formation*—Bradley Stoughton and F. J. G. Duck, Lehigh University, Bethlehem, Pa.

3:30 P. M.—*Oil Burning Equipment for Industrial Furnaces*—M. H. Mawhinney, General Furnace Co., Pittsburgh.

Dr. Anson Hayes presented the first paper; W. J. Merten the second; F. J. G. Duck the third and M. H. Mawhinney the fourth. Considerable written and oral discussion was presented at this session.

Annual Grand Ball

The Annual Grand Ball of the society was held in the Ball Room of the Hotel Cleveland, commencing at 9:30 P. M. and lasting until 1:00 A. M. This was a well attended party and was a credit to the committee who was in charge of arrangements. The music was of a very high order and the refreshments so

Views of the Exposition

Views of the Exposition

tasty that the committee had to replenish the supply a number of times.

Thursday, September 17

The morning technical session was held in the Ball Room of the Hotel Cleveland and was called to order at 9:30 A. M. by the chairman, Dr. Albert Sauveur. The following three papers were presented at this meeting:

9:30 A. M.—*Initial Temperature and Mass Effects in Quenching*—H. J. French and O. Z. Klopsch, Bureau of Standards, Washington, D. C.

10:20 A. M.—*On the Nature of Some Low-Tungsten Tool Steels*—M. A. Grossmann, United Alloy Steel Corp., Canton, Ohio, and E. C. Bain, Union Carbide & Carbon Research Laboratories, Long Island City, N. Y.

11:10 A. M.—*Effect of Cold Working on the Strength of Hollow Cylinders*—Dr. F. C. Langenberg, Watertown Arsenal, Watertown, Mass.

The first paper was presented by H. J. French; the second by M. A. Grossmann and the third by Dr. F. C. Langenberg. Each of these papers was followed by a very comprehensive discussion, both written and oral.

Two technical sessions were held Thursday afternoon at 2:00 P. M. in the Hotel Hollenden. One session was contributed by the American Society of Mechanical Engineers and was held in the Ball Room. The other was a symposium on hardness testing conducted under the direction of the hardness testing committee of the A. S. S. T.

The session contributed by the A. S. M. E. was presided over by Colonel E. C. Peck. Four papers were presented at this meeting as follows:

Use of Machinery in Making Dies for Sheet Metal Work and Forging—S. A. Keller, Keller Mechanical Engineering Corp., Brooklyn, N. Y. (Presented by John C. Shaw.)

Recent Development in Surface Grinding—H. K. Spencer, Blanchard Machine Co., Cambridge, Mass.

Centerless Grinding—W. J. Peets, engineer in charge of factory materials, Singer Mfg. Co., Elizabethport, N. J.

The Steel Missionary—W. H. Rastall, chief industrial machinery division, Department of Commerce, Washington, D. C.

The hardness testing symposium, under the chairmanship of

Major A. E. Bellis, was held in the Assembly Hall of the Hotel. Six papers were scheduled for this session as follows:

2:00 P. M.—*Elastic Ring for Verification of Brinell Hardness Testing Machines*—S. N. Petrenko, Bureau of Standards, Washington, D. C.

2.20 P. M.—*Some Comparisons between Rockwell and Brinell Hardness*—R. C. Brumfield, Cooper Union, New York City.

2:40 P. M.—*Hardness and Toughness of High Speed Steel as Affected by the Heat Treatment*—R. K. Barry, Barry Co., Muscatine, Iowa.

3:00 P. M.—*Stress-Strain Curve and the Characteristics Which Are Associated with Hardness*—H. P. Hollnagel, General Electric Co., West Lynn, Mass.

3:20 P. M.—*English Hardness Testing Machine of the Brinell Principle*—O. W. Boston, University of Michigan, Ann Arbor, Mich.

3:40 P. M.—*The Durometer—An Instrument for Testing Hardness*—Dr. Albert Sauveur, Harvard University, Cambridge, Mass.

Each of these papers was presented by the author and in the order scheduled. Considerable discussion followed each of these papers, revealing the large amount of interest that exists on the subject of hardness testing.

The Annual Banquet

The annual banquet of the A. S. S. T. was held in the Ball Room of the Hotel Cleveland at 6:30 P. M., Thursday, September 17. There was an attendance of about 450 members and guests. George M. Graham, vice-president of the Chandler Motor Car Co., was the toastmaster, and the city manager of the City of Cleveland, W. R. Hopkins, was the principal speaker.

President W. S. Bidle read a cablegram of greeting from Sir Robert Hadfield of London, England, an honorary member of the society. The cablegram read as follows:

> As one of your honorary members, a privilege I greatly esteem, permit me to offer your society my heartiest good wishes for the entire and complete success of this great and unique gathering. Long may the science of metallurgy flourish, root and branch.—Robert Hadfield.

To which the following reply was cabled by the society:

> The board of directors and members acknowledge with sincere appreciation your cordial greetings and good wishes. We regret you cannot be with us, but look forward to the time when you may. We wish you continued good health.

Annual Banquet of the American Society for Steel Treating, Ball Room, Hotel Cleveland, September 17, 1925

W. R. Hopkins, city manager of the City of Cleveland and principal speaker, was then introduced. In introducing Mr. W. R. Hopkins, the toastmaster made the following remarks:

"It is appropriate that Cleveland's first citizen, who has to do with safe-guarding the interests of the million members of his Corporation, who must see to it that we have order without oppression, that we have liberty without license, that we have progress without extravagance, should welcome this splendid gathering tonight. In the person of Mr. Hopkins we are making the great municipal experiment of substituting business common sense for political manipulation. I warn those of you who come from other cities that if you adopt this experiment we do not promise the same measure of success that we are enjoying, because with every good will to your test, we question if in many places it will be found possible to find a man who combines all the factors of administering such a system as does our city manager, Mr. W. R. Hopkins, whom it is now my pride and privilege to present.

Mr. W. R. Hopkin's Speech

Mr. Toastmaster, ladies and gentlemen: Such an introduction ought to leave anybody, even an office holder, speechless. Let me say at the very outset, before I say some words of congratulation to ourselves on account of this meeting, that the city manager of Cleveland is a little in the same position in the administration of the city that Colonel Roosevelt said he was in at San Juan Hill. Somebody spoke to him once and complimented him on the speed with which he got up the hill and the Colonel very promptly snapped out that if he had gone any slower he would have been run over. The fact of the matter is, ladies and gentlemen, that whatever success we attain in Cleveland with this new form of government will be primarily due to the fact that the form itself is the result of a very profound desire on the part of the community to have a better form, a more effectual type of city government, and to the sincere, general and whole-hearted support which the community has given to every effort to give them the thing they want. And so, I think it may be said with truth that no city can hope to get any great improvement in its city government until the mass of the people in that city so sincerely desire it that those who under-

take to furnish that kind of government may be reasonably immune from all the attacks and all the insidious influences which have so long operated to degrade the quality of government in all its branches.

At the bottom, it is a fact that in this country we get the kind of government we really want. But before I get further in that, I want to express to you the very great pleasure that you have given the City of Cleveland. We are very happy when any national gathering comes here, and many notable ones have come here. We are very happy to welcome a body of people like this to the City of Cleveland. But we are especially happy to welcome in this organization this great body of pioneers in the development of the greatest and the most fundamental of all our industries. It is not without just a little sense of regret that I look at this body of men and think of what they were doing, because I myself was born to the steel business. My ancestors, as far back as I know much about them, for hundreds of years at least, in Wales and in England, were in both branches of the iron business, that is, in the iron and in the mine, and I myself served a rather substantial apprenticeship in the mills here and so, of course, I am interested. And while I do not feel very old, I have contrasted, as I have read the newspaper accounts of various papers that were read here, the condition in the mills when I worked there, when we had one chemist who undertook to take care of a very large plant and who, in our branch of it, in the wire mill end of it, was occasionally borrowed for a single analysis of spring wire from which we undertook to determine why one spring acted differently from another. Although we used sulphuric acid, for example, by the car load, there was nobody in the whole plant who had any real knowledge of what it was. It was all cut and try.

I had a serious, a very serious notion once of fitting myself technically for the wire business. But it so happened that I noticed that whenever there was a place of any account in those days for anybody to fill that the method of promotion was more political than industrial. That some relative, and sometimes amazingly remote ones, was always at hand to step into every position that was worth having. And so I strayed off into the fields that finally landed me in the City Hall.

Now there are several things I would like to say to you, be-

cause they are of general interest. When I was drafted for this position, the principal thing that moved me was the hope that I might, while public interest was keen in city government, accomplish certain great public improvements that I felt were necessary to the progress of the city. It had not occurred to me that this local desire for better government was anything more than an ephemeral reaction from quite the opposite condition. Certainly I had no reason to think that this desire which we had here was at all general. I have learned during the last year and a half or so that the thing that happened in Cleveland is simply one symptom of a feeling which seems to be general in this country. At any rate, I have been invited to go to so many places to help people find some way to improve their municipal government that I do not hesitate to say to you that all over the North, at least, there is a profound feeling in this country that the government of our cities is unworthy of us.

If I may use an illustration that may at first seem extreme, I will say that it seems to be a little like the situation with reference to slavery. It took nearly 80 years for the American people to become so profoundly dissatisfied with the essential incongruity of a free country professing to be founded upon principles of justice and yet sanctioning legally the existence of human slavery, it took 80 years before the incongruity of that thing drove the American people to action.

Now that incongruity, to my mind, is no more real than the incongruity between American ideals of government and the thing we actually have, at least, in our great cities. In this country, first in all the world, we laid down the proposition that government should be founded, not on geography, not on nationality, not on dynasty, but upon principles; that governments were not things that descended upon people, they were things which people ought, of right, to create for their own benefit, to preserve justice, to promote the public health and, above all, to promote the public welfare.

Here, first in all the world, was laid down the proposition that government should be an organization designed and operated for certain express purposes and that its very right to exist depended upon the measure of its efficiency to accomplish those purposes. And that whenever the governmental machine ceased to be the best possible machine for the accomplishment of

those purposes, that the people living under it had a right and a duty to change the machine. Of course, in the Declaration of Independence, that meant to throw off the sovereignty of England, but fundamentally that was the idea at the bottom.

We say that we believe the power of government is a sacred thing, springing from the people to be used with justice, to be so used that all men shall be truly equal before it, that there shall be neither favor nor oppression and, above all, that it represents a new and an additional power whereby a people may promote all of those interests which they may value as an intelligent and civilized people. Measured by that standard, the government of any of our great cities, New York, Boston, Philadelphia, Chicago, if you please, is just as incongruous as slavery was in 1850. There is nothing American in a government where sets and cliques of men seize by any means that they can the power of government and proceed to use it for their own benefit, and the benefit of their friends, to the detriment of everybody else. The sin of American municipal government consists in the fact that it is un-American, that favor, I would not say fraud, that incapacity, that inefficiency and insufficiency are its characteristic marks.

So far have we tolerated that that it has been a saying in many cities that the grafters and the gangs stole less than the uplifters would lose by reason of their lack of capacity, and men who would scorn the idea that they were not good Americans not only put up with types of government that were absolutely un-American, but even profited by them, if need be.

Now all over this country people have a feeling about municipal government which is bound to result in greater changes. In the city of Rochester recently, in mid-summer, I was asked to address something like 3000 people who had organized without heat, without excitement, without a campaign, without crusade, to get a better government for Rochester. Now there was no outstanding abuse in that city. It was simply the conviction that the government of that city was dominated by ideas and by forces and directed toward objects inconsistent with the quality of such a community, that it was unworthy of them as an American city such as that was.

Now that thing is bound to result in a great change in our municipal governments and, of course, that change must take the

form of applying to municipal government the same kind of intelligence that you gentlemen are applying to the steel business. You cannot get good results in government by any different process than you can get them in anything else. It means that we must abandon the idea that public position is to be obtained and held upon any basis other than the qualification of the person holding the position to discharge it in the best possible way. Ideal, you say. Yes, but the American ideal, the original American ideal about government.

Another thing. I need not say to you, it is almost an aphorism now, but men all over the world of every color are asking more questions about government than ever before. Within the space of a few years we have seen the collapse of great empires, the total disappearance of dynasties and all over the world we see men of every kind challenging the very right of the government under which they live to go on living.

Now it is not impossible that in a country like this where the prices of government are so great, where the power of government is so great, where the advantage of control is so tremendous, where the desires of the people are so great and, above all, where the peril of periods of depression necessarily increases, where because of the elaboration of the machine, where because of the constant change in industry, the constant development of new things, the production of new articles and the inevitable disarrangement in the industrial structure resulting from that, it is inevitable that we should, as time goes on, fall into periods of great depression. It is inevitable that out of industrial confusion shall come social want and distress, and we know that those times are the open invitation to every man who wants a short cut to power, to every man with a glib tongue and a plausible theory to say to the man in distress that his distress is wholly due to the government and to tell him that the one way out of trouble is to change the government.

Now I am not going to say to you that the success of the American people is in almost direct proportion to the extent to which we have adhered to American ideals, but I believe that. I believe that fundamentally what we have done in this country is but the flowering, the partial fruit of those great truths upon which this government was founded. Now if in time of trouble the only government that great masses of men know, the local

government, if it is an incompetent thing, if it is a weak thing, if it is a thing they do not respect, how can we expect them in times of trial and stress to have faith in the government at Washington that they cannot see?

One more thought. If there is anything in the American idea of government and the possibilities of government in the promotion of the public welfare, ought not that idea to be most effectual and most fruitful in the localities where we must live, where the government touches us every morning, every hour of the day, where it serves us increasingly, where it helps or hinders us more and more, where its burdens upon us are steadily mounting, if there is anything in the American idea of government and any benefit to be derived from it, is not the locality the place where we should get the maximum benefit of those ideas? If there is anything in the idea of selecting officials to carry out the public will, ought not it to be most successful in localities where people can know the men they elect? If there is anything in the idea of public sentiment about public questions, ought it not to be most valuable in those questions where the most common man may have some opinion as to what should be done?

When we come to state and national matters, the ordinary man cannot know much, of his own knowledge, as to what should be done, he cannot know many of the men he votes for, but in our local government we can know who we choose and what we are about. And so, I say to you, my friends, I really believe that we are at the beginning of a period in which the American people will begin to build American government at the bottom, where we are going to make government American at the source, where we are going to get through all our local governments those benefits and those advantages which from the beginning we have professed as Americans to believe will and must flow from a government that is just, that is intelligent, that is efficient and that is truly devoted to the public welfare.

I thank you very much for your indulgence and I crave your pardon for having to leave you, and with this I must say Good Night.

Following the usual custom of presenting the past president's medal, Dr. G. K. Burgess, director of the U. S. Bureau of Stand-

ards, was awarded the past president's medal for his valuable services rendered to the society during his administration for the year of 1924. After receiving the medal from President Bidle, Dr. Burgess acknowledged it in a fitting manner.

Arthur G. Henry made a Founder Member

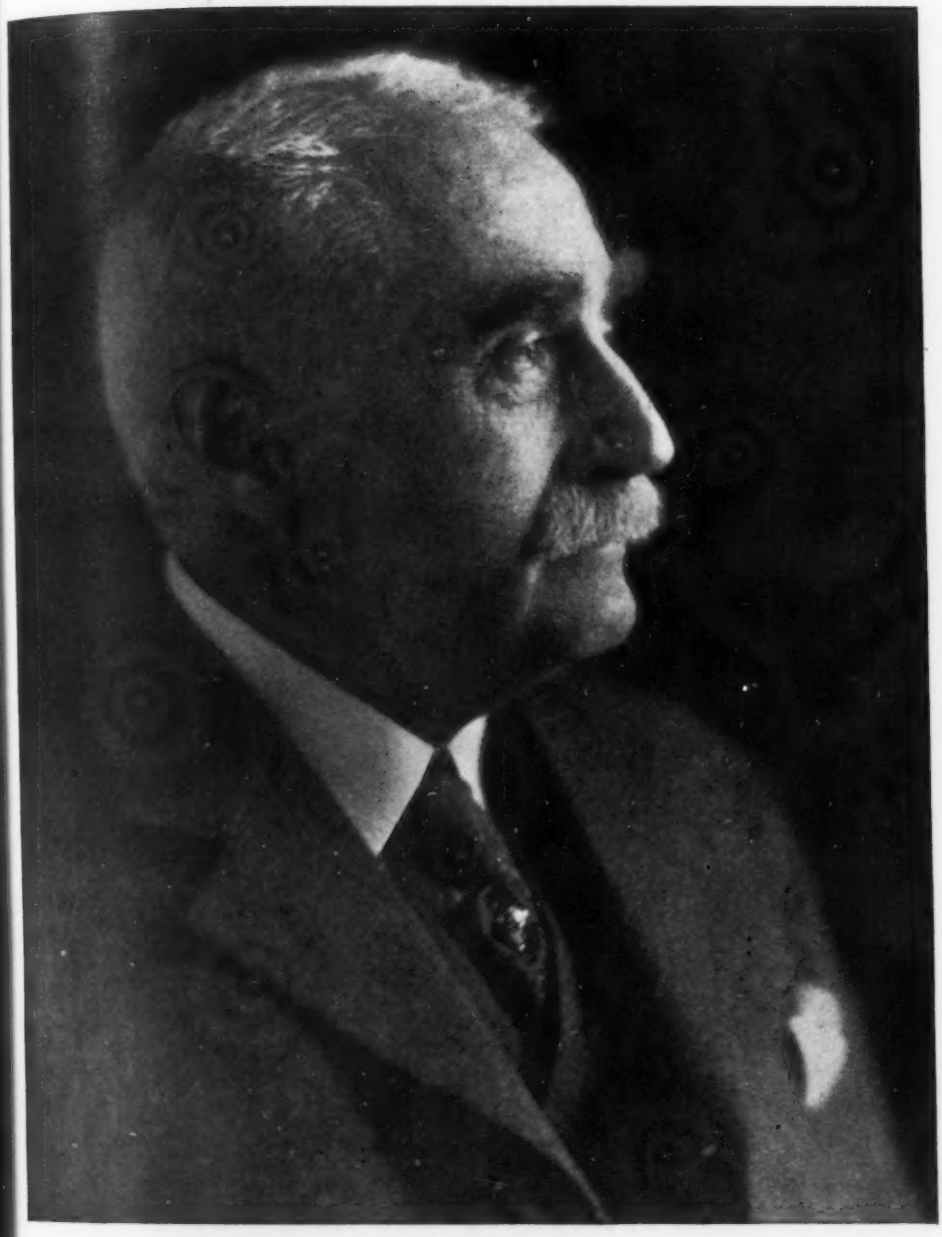
Following this presentation President Bidle announced the action of the board of directors in conferring a founder member-

ARTHUR G. HENRY

ship in the society in favor of Arthur G. Henry of Chicago. In making public this action of the board it was emphasized that Mr. Henry, who was one of the members of the original Chicago chapter, was largely responsible for the idea of holding an exhibition in connection with the annual convention of the society. To him is given much of the credit in the organization of the first exhibition held by the society in Chicago in 1919.

Charles F. Brush Made an Honorary Member

To Charles Francis Brush, the eminent scientist and physicist of Cleveland, was given honorary membership in the society. This honor was conferred upon Dr. Brush by Dr. Zay Jeffries, who preceded the award by a brief account of the achievements of this noted scientist's career. Dr. Brush, in accepting this membership, expressed his appreciation of the honor in a few well-chosen words.



CHARLES F. BRUSH
Honorary Member of the Society

The 1925 Howe Medalist

To Dr. Horace H. Lester, research physicist, Watertown Arsenal, Watertown, Mass., was presented the 1925 Henry Marion Howe medal. This award was made to Dr. Lester, in recognition of his paper entitled "X-Ray Tests Applied to Problems of the Steel Foundry" which had been judged to be the one of highest

merit published in TRANSACTIONS during the 12 months from August 1, 1924, to August 1, 1925.

After the announcement of the award, Dr. Lester received the medal from Mrs. Howe herself. Mrs. Howe, the widow of the distinguished metallurgist, sat at a table close to the speaker's table and for the first time presented the medal in person. Mrs.

HORACE H. LESTER
Howe Medalist, 1925

Howe was present in Pittsburgh when the first Howe medal was awarded to Mr. E. J. Janitzky.

Horace Hardy Lester was born at Shelburn, Indiana, Dec. 30, 1883. He received his primary education in schools of Carlisle, Indiana, his secondary education at Vincennes University (Ind.); University of Minnesota, B. A. 1906; University of Washington, M. A. 1912, and Princeton University, Ph. D. 1915.

He was instructor in physics at Princeton University in 1914-1915; instructor in physics at the University of Washington, 1915-1917; was in war service in the radio laboratory, Navy Yard, Puget Sound, 1917-1920; physicist, Westinghouse Lamp Co., 1920-1921. Was assistant professor of physics, Case School of Applied Science, (Cleveland) 1921-1922 and research physicist, Watertown Arsenal, Watertown, Mass., 1922. Dr. Lester is a

member of Sigma Xi (Honorary science fraternity) and a member of the American Physical Society, the American Society for Steel Treating, the American Society for Testing Materials, and a member of the A. S. T. M. committee on X-Ray Metallography.

The following publications are to the credit of Dr. Lester:

"A New Method for Determining the Index of Refraction of Water," *Physical Review*, Sept., 1912.

"The Work Function that Occurs When an Electron Escapes from the Surface of a Hot Body," *Philosophical Magazine*, (London), Vol. XXXI, March, 1916.

"The Variation of Thermionic Currents With Potentials," *Philosophical Magazine*, Vol. XXXI, June, 1916.

"The Radiography of Metals," *Army Ordnance*, Jan.-Feb., 1923.

"X-Ray Examination of Steel Castings," *Chemical and Metallurgical Engineering*, Vol. 28, No. 6, Feb., 1923.

"X-Ray Tests Applied to Problems of the Steel Foundry," TRANSACTIONS of the American Society for Steel Treating, Nov., 1924.

"Using X-Rays to Detect Hidden Defects in Plant Equipment," *Chemical and Metallurgical Engineering*, Vol. 31, No. 16, 1924. (Joint Paper with E. C. Herthel, Wm. V. Ischie, and Wm. Mendius.)

"Crystal Deformation in Cold Worked Steel," *Army Ordnance*, Vol. V, No. 25, July-August, 1924.

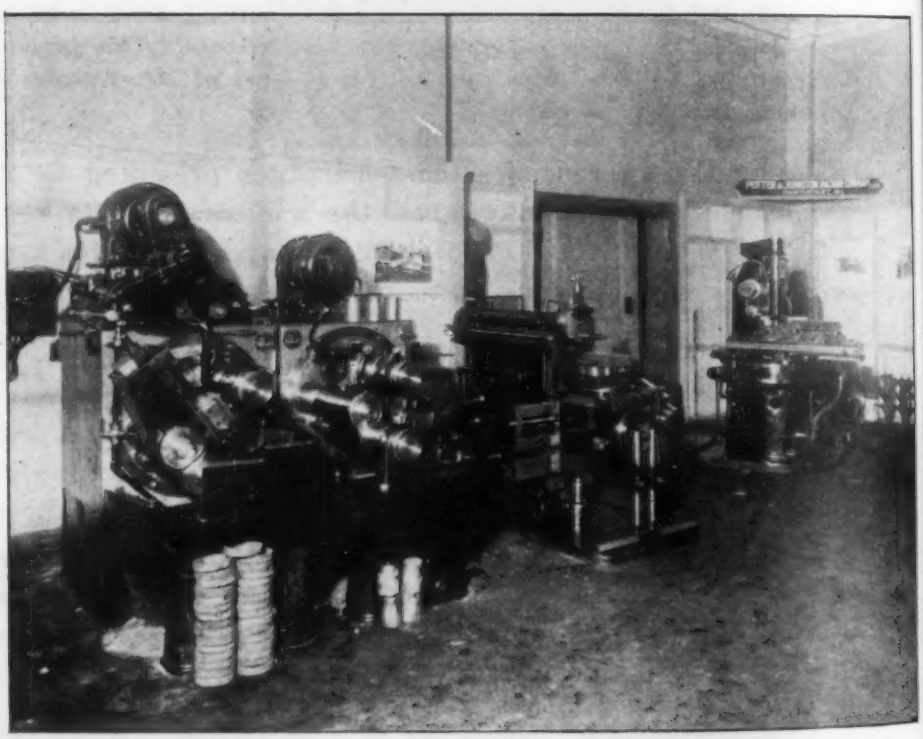
"The Deformations of the Iron Crystals in Steel," *Army Ordnance*, Sept.-Oct., 1925. (Joint paper with Dr. R. H. Aborn. This paper is being printed in three parts in consecutive issues of *Army Ordnance* beginning with September, 1925.)

Following these ceremonies the toastmaster presented C. M. Newcomb, humorist, who entertained the audience with a very humorous talk entitled the "Psychology of Laughter." He kept his listeners in a continuous state of laughter and incidently brought out some interesting facts regarding factors entering into the psychology of laughter.

FRIDAY, SEPTEMBER 18

Three technical papers were scheduled for the Friday morning technical session which was held in the Ball Room of the Hotel Cleveland at 9:30 A. M. The chairman for this meeting was Bradley Stoughton of Lehigh University. The papers that were presented are as follows:

9:30 A. M.—*Carburization by Solid Cements*—W. E. Day, Jr., International Motor Co., New Brunswick, N. J.



Views of the Exposition

10:20 A. M.—*Dilatometric Method of Heat Treatment*—O. E. Harder, R. L. Dowdell and A. C. Forsythe, University of Minnesota, Minneapolis, Minn.

11:10 A. M.—*What Happens When Metal Fails by Fatigue*—Professor H. F. Moore, University of Illinois, Urbana, Ill.

Each of these papers was presented by the respective author, Dr. Harder presenting the second paper.

The last technical session of the convention was held in the Ball Room of the Hotel Hollenden at 2:00 P. M., the chairman being Prof. H. M. Boylston of Case School of Applied Science, Cleveland. Three papers were presented at this session as follows:

2:00 P. M.—*Why Metal Warps and Cracks*—J. F. Keller, Purdue University, Lafayette, Ind.

2:40 P. M.—*Design and Operation of Furnaces for Salt Baths*—Sam Tour, Doehler Die Castings Co., Batavia, N. Y.

3:20 P. M.—*Welding Steel Tubing and Sheet with Chromium-Molybdenum Welding Wire*—F. T. Sisco and H. W. Boulton, McCook Field, Dayton, Ohio.

The first two papers were presented by the respective authors, while the third one was read in abstract by R. T. Bayless. Each of these papers brought out considerable discussion, both written and oral.

Plant Inspection

Many members and guests availed themselves of the opportunity of visiting various plants in Cleveland. The plants which were officially scheduled for inspection are as follows:

The Ohio and Western Pennsylvania Dock Co.,
The National Carbon Co.,
The White Motor Co.,
Otis Steel Co.,
The Cleveland Electric Illuminating Co.,
American Steel and Wire Co., Cuyahoga Plant.

The following plants were open for inspection by appointment:

Chandler Motor Car Co.,
Cleveland Automobile Co.,
Peerless Automobile Co.,
Van Dorn & Dutton Co.,
Van Dorn Electric Tool Co.,
Warner and Swasey Co.,
Brown Hoisting Machinery Co.,

Views of the Exposition

All of the regularly scheduled plant inspection trips were exceptionally well attended.

The Golf Tournament

The golf tournament, arranged by W. F. Abel, chairman of the men's entertainment committee, proved to be one of the attractive features of the convention. On Wednesday morning a group of 74 members and guests assembled at the Kirtland Country Club and played an 18-hole game. Unfortunately the weather was not very good and 16 of the players dropped out of the game before they had played the 18 holes. The contestants were divided into two classes, A and B. Many attractive trophies had been supplied by the committee. These trophies were awarded as follows:

Class A

Low Gross

Cup donated by the Hollenden Hotel, Cleveland.
Won by—M. A. Smith, Edgewater Steel Co., Pittsburgh.

Low Net

Set of Monel Clubs donated by the International Nickel Co., New York City.
Won by—W. L. Appel, E. C. Atkins Co., Indianapolis.

Runner Up—Low Gross

Sweater donated by W. B. Davis Co., Cleveland.
Won by—Grant Folin, Union Twist Drill Co., Athol, Mass.

Low Number of Putts

"Autograph" Brassie donated by A. G. Spalding and Bros., Cleveland.
Won by—J. B. Mudge, International Nickel Co.

Class B

Low Gross

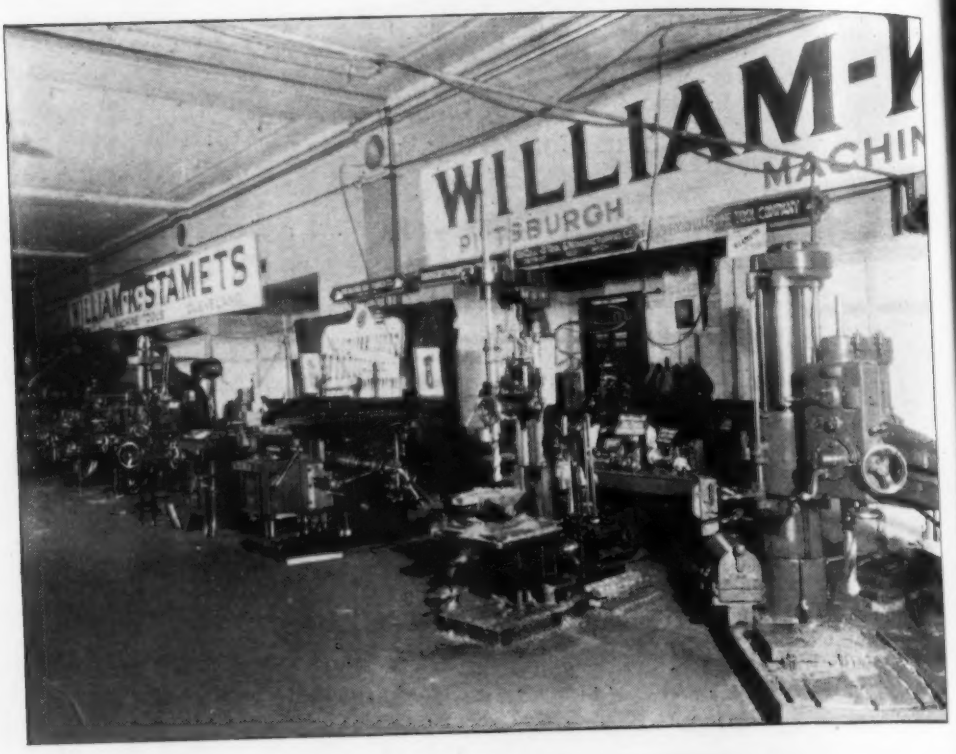
Set of Stainless Steel Clubs donated by the Firth-Sterling Steel Co., Cleveland.
Won by—Hugh Rodman, Rodman Chemical Co., Verona, Pa.

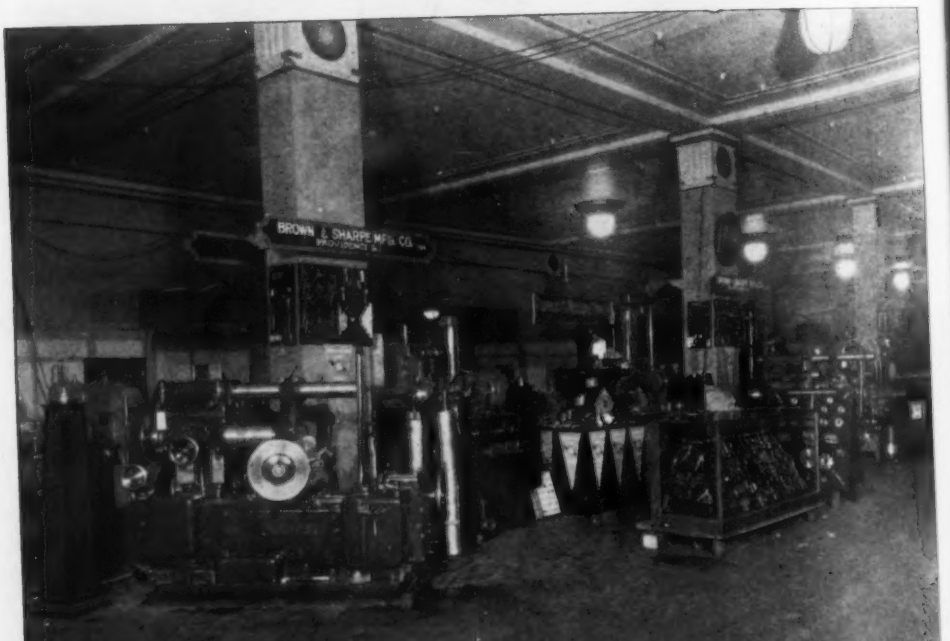
Low Net

Golf Bag donated by J. W. Kelley Co., Cleveland.
Won by—G. W. Tall, Jr., Leeds & Northrup Co., Philadelphia, Pa.

Runner Up—Low Gross

Foil Steel Fishing Rod donated by the American Fork and Hoe Co., Cleveland.
Won by—H. Hardwick, Atlas Alloy Steel Co., Chicago.





Views of the Exposition

Low Number of Putts

Pair of Stetson Golf Shoes donated by Thomas Ferry of the Ferry Cap & Set Screw Co., Cleveland.

Won by—J. S. Ayling, Case Hardening Service Co., Cleveland.

Greatest Number of Birdies

1 Dozen St. Mungo Golf Balls donated by the St. Mungo Mfg. Co., Newark, N. J.

Won by—Dr. A. E. White, Ann Arbor, Mich.

Ladies Entertainment

About 200 visiting ladies were entertained by the Cleveland ladies with a number of very interesting and enjoyable parties and sight-seeing trips around Cleveland.

On Monday the ladies were escorted to Wade Park Manor where a most enjoyable luncheon was served.

On Tuesday a luncheon was served at Nela Park after which the ladies inspected the lighting exhibits and museum at Nela Park.

In the evening all of the ladies were entertained at a theater party at Keith's Palace. About 200 were present for this event.

A luncheon and bridge party was held at the Women's Club Wednesday afternoon, and the Annual Grand Ball provided entertainment in the evening.

On Thursday the committee had arranged an automobile trip on the west side of the city returning in time for the annual banquet held in the Ball Room of the Hotel Cleveland at 6:30 P. M.

No regularly scheduled program was arranged for Friday.

The S. A. E. Production Meeting

A large attendance, a full program and a very active participation in the discussion of the papers which were presented at the production meeting of the Society for Automotive Engineers, which was held at the Hotel Winton, September 14, 15, and 16, resulted in a very profitable meeting. This meeting was held simultaneously with the convention and exposition of the American Society for Steel Treating.

This simultaneous meeting of the S. A. E. with A. S. S. T. made it possible for the automotive group of the S. A. E. to join in the general activities of the A. S. S. T. and to visit the exposition of heat treating equipment and machine tools. This arrangement provided the S. A. E. members the opportunity of

inspecting many of the latest models of time-saving machine tools in operation on actual automotive production work.

Six technical sessions were provided, two of which were devoted to machine tool equipment. The other sessions were divided into four different groups which included sheet steel, fabrication, inspection, gear production and foreman training.

The papers which were presented at these sessions are as follows:

Hot Stampings—G. F. Keyes, Mullins Body Corporation.
Sheet Steel Fabrication—Syd Smith, Studebaker Corporation of America.
Training Employees in Production Work—Lillian M. Gilbreth, Gilbreth, Inc.
Products and By-Products of Foremen's Conferences—F. T. Jones, White Motor Company.
The Training of Shop Foremen—Louis Ruthenberg, Yellow Sleeve Valve Engine Works, Inc.
Coordinating Designs and Production Methods in Gear Development—Perry L. Tenney, Muncie Products Division, General Motors Corporation.
The Problem of Gear Production—Earle Buckingham, Niles, Bement, Pond Company.
Machine-Tool Needs of the Automotive Industry—R. M. Hidey, White Motor Company.
Machine-Tool Selection—W. G. Careins, Ajax Motors Company.
Analysis of Machine-Tool Maintenance—A. R. Kelso, Continental Motors Corporation.
Jigs and Fixtures in Automotive Production—J. Gustaf Moobl, Cleveland Automobile Company.
Making Machine Tools Safe—R. F. Thalner, Buick Motor Company.
Inspection Methods—C. J. Ross, Buick Motor Company.
Some Aspects of Inspection in the Airplane Industry—John J. Feeley, Glenn L. Martin Company.

MINUTES OF THE MEETING OF THE BOARD OF DIRECTORS

HOTEL CLEVELAND

September 16, 1925, 12:30 P. M.

There were present:

W. S. Bidle
R. M. Bird
J. F. Harper
Zay Jeffries
F. G. Hughes
P. D. Merica
F. E. McCleary
G. K. Burgess
W. H. Eisenman

UPON motion by Mr. Hughes, seconded by Mr. Harper and unanimously carried, the minutes of the last meeting were approved.

Upon motion by Dr. Burgess, seconded by Dr. Merica, and unanimously carried, the question of the establishment of a lectureship by the A. S. S. T., was left to a committee composed of the president, secretary and treasurer, with authority to obligate the society to expend not over $500 in the carrying out of this lectureship. This committee is also to have authority to select the lecturer for 1926.

Upon motion by Mr. Hughes, seconded by Mr. McCleary, and unanimously carried, the winter sectional meeting will be held in Buffalo on January 21 and 22, and the spring sectional meeting at Hartford on dates to be selected later.

The following communication was received from Sir Robert Hadfield:

"As one of your honorary members—a privilege I greatly esteem—permit me to offer your society my heartiest good wishes for the entire and complete success of this great and unique gathering. Long may the science of metallurgy flourish root and branch."

The Board of Directors authorized sending the following reply:

"The Board of Directors and members acknowledge with sincere appreciation your cordial greetings and good wishes. We regret that you cannot be with us but look forward to the time when you may. We wish you continued good health."

Upon motion by Mr. McCleary, seconded by Dr. Burgess and unanimously carried, it was decided that a committee, composed of the president, vice-president, and secretary, be appointed to investigate the desirability of affiliation of the A. S. S. T. with the American Engineering Council and also with the American Engineering Standards Committee.

The following communication was received:

"Recognizing and appreciating the force contributed to the American Steel Treaters' Society in its conception, inception and development by Arthur G. Henry, its first national secretary, and being familiar with his unlimited and effective efforts in the society's behalf at that critical time, and realizing, further, the society's debt to him because of his inception and energetic pro-

motion of the exhibition idea, and believing that it would be a fitting mark of esteem to elect said Arthur G. Henry to founder membership in the American Society for Steel Treating, whose present usefulness and prosperity is in no small measure due to his early influence, we, the undersigned members of the American Society for Steel Treating, hereby nominate Arthur G. Henry of Chicago, Illinois, for founder membership and earnestly petition your honorable body for his election. (Signed) T. E. Barker, E. J. Janitzky, Horace H. Clark, Arthur W. F. Green, F. F. Cauley, R. G. Guthrie, Frank A. Wheeler, F. S. Crane, Howard J. Stagg and A. E. White.

Upon motion by Dr. Jeffries, seconded by Dr. Burgess and unanimously carried, Arthur G. Henry was elected to founder membership, the announcement to be made at the annual banquet in Cleveland, while the founder membership is to be conferred at the annual banquet in Chicago in 1926.

Upon motion properly made, seconded and carried, the secretary was authorized to send a communication of greeting to past president F. P. Gilligan.

Upon motion by Dr. Jeffries, seconded by Mr. Harper, it was unanimously carried that a booklet be published, to be forwarded to executives, acquainting them with the work of the society and pointing out the ways in which they might cooperate in the work.

Upon motion properly made, seconded and carried, the meeting adjourned. Respectfully submitted,

Signed:—W. H. EISENMAN,
Secretary.

HONORARY MEMBER OF THE SOCIETY DIES

EDWARD DEMILLE CAMPBELL, professor of chemical engineering at the University of Michigan and honorary member of the Society, died at his home in Ann Arbor, Michigan, September 19, 1925. Professor Campbell achieved unusual fame in metallurgical lines in spite of the handicap of his blindness, caused by an explosion while he was conducting an experiment in the chemical laboratory of the University of Michigan in 1892. At the time of this accident he was 28 years old.

Professor Campbell was born September 9, 1863, and was

Edward DeMille Campbell

1863 -:- 1925

graduated from the University of Michigan in 1886. Following graduation, he served as metallurgical chemist for the Ohio Iron Co., Zanesville, Ohio, 1886-87; for the Sharon Iron Co., Sharon, Pa., 1887-88; and the Dayton Coal and Iron Co., Dayton, Ohio, 1888-90. In 1890 he left the industrial field to serve his alma mater and was made assistant professor of metallurgy. He became a junior professor of metallurgy and metallurgical chemistry in 1893; junior professor of analytical chemistry in 1905; professor of chemistry and director of the chemical laboratories in 1914, serving in this capacity until his death.

Professor Campbell's blindness was caused by an explosion which occurred while studying the chemical constitution of steel. For eight years previous to this, he had been studying the chemical constitution of steel, and on this particular day he was experimenting with the gases obtained by dissolving steel in hydrochloric acid, gases which contain large percentages of hydrogen. In this experiment he was oxidizing the hydrogen, using a method which was entirely practicable. While closely observing operations, a violent explosion occurred which shattered the glass apparatus and instantly destroyed the sight of both eyes. Within five days Professor Campbell was again in his laboratory.

In the thirty-three years which have passed since this terrible accident, Professor Campbell has continued his scientific studies on the structure of iron and steel and has made many valuable contributions to the literature. He has been a very capable teacher and has trained many men for their work in life. Professor Campbell had a most unusual power of concentration. He depended largely upon his assistants to read to him from scientific journals.

Professor Campbell was elected an honorary member of the American Society for Steel Treating in June, 1921, in recognition of his research work. He was a member of the American Chemical Society; Iron and Steel Institute; Faraday Society; Washington Academy of Sciences; Michigan Academy of Sciences; Tau Beta Pi; Michigan State Gas Association; Society of Detroit Chemists; Alpha Chi Sigma; Sigma Psi and Phi Lambda Upsilon.

EFFECT OF COLD WORKING ON THE STRENGTH OF HOLLOW CYLINDERS

By F. C. Langenberg

Abstract

This paper describes a process of manufacture in which the physical properties of large size simple hollow cylinders may be greatly increased over the usual properties obtained. The paper discusses the principals involved in the computation of the strength of gun tubes and jackets.

The apparatus employed in the manufacture of gun tubes by the cold working process is described in detail and illustrated with photographs and graphs. The results of cold working compound guns is compared with the results of the cold-worked simple gun.

Studies have been made of the effect of annealing operations on the elastic strength of cold-worked simple and compound cylinders, after different amounts of cold working had been applied.

The application of the cold working method for increasing the elastic strength of hollow cylinders has a very decided advantage in the production of guns resulting in the saving of both time and money.

ONE of the most common structural forms encountered in mechanical devices is the simple hollow cylinder. Although its uses are many and varied, it is desired in this paper to consider only their application as pressure containing vessels. Everyone is familiar with the ordinary gas cylinder, a comparatively thin walled vessel, confining two or three thousand pounds per square inch. One of the opposite extremes is a gun tube with its jackets which may be called upon to withstand pressures in service of over 40,000 pounds per square inch without permanent enlargement.

Although everyone is familiar with the acknowledged formulas for computing the strength of hollow cylinders, the condition present within their walls while under stress is not generally appre-

Published by permission of General C. C. Williams, Chief of Ordnance, U. S. Army.

A paper presented before the Cleveland Convention of the Society, September, 1925. The author, Dr. F. C. Langenberg, is director of laboratories, Watertown Arsenal, Watertown, Mass.

ciated. A simple hollow cylinder when subjected to an interior pressure does not have the stresses within its walls efficiently distributed. An element of a given thickness in the outer portion of such a cylinder is under a very low stress while at the same time being of greater weight than an inner element of the same thickness which carries a very high stress.

A very common size of cylinder encountered in practice is one in which the wall thickness is equal to the interior diameter; that is, the outside diameter is three times the interior diameter. In ordnance practice, such a cylinder would be described as being "one caliber in thickness." One of the commonly accepted formulas for the computation of the tangential stress in a hollow cylinder, which is generally the principal stress, is as follows:

$$P_o = \frac{3\,(R_1^2 - R_o^2)}{2\,(R_o^2 + 2R_1^2)} S_t, \text{ in which}$$

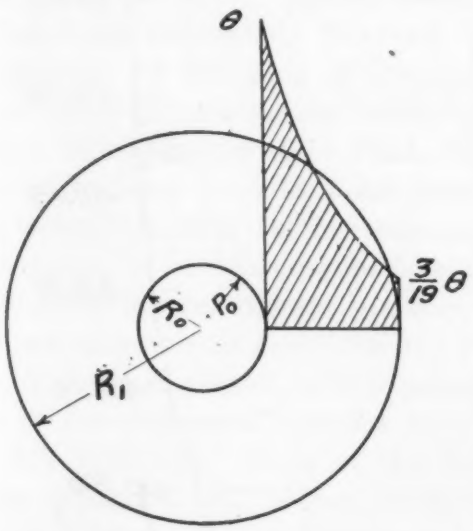
R_1 = outside radius
R_o = inside radius
P_o = internal pressure
S_t = tangential stress on the inner annulus.

Utilizing this formula in the consideration of the cylinder mentioned above, it can be shown that the greatest pressure which can be confined in such a cylinder without stressing the inner annulus beyond its elastic limit is only 63 per cent of the elastic limit of the steel from which the cylinder is made.

Assuming an elastic limit of 50,000 pounds per square inch, such a cylinder could withstand a pressure of 31,500 pounds per square inch without taking a permanent set. Although the inner annulus of a cylinder may be stressed to its elastic limit, the stress rapidly drops from the bore to the outer surface of the cylinder. The stress in the outer annulus of a cylinder having a wall thickness equal to its interior diameter is only 3/19ths of the stress at the inner annulus, whereas the weight of an element at the outer annulus is nine times the weight of a similar element at the inner annulus. The distribution of stress in the cross section of a cylinder having one caliber wall thickness is shown in Fig. 1, the actual intensity of stress at any radius being plotted as ordinates.

If a cylinder is to function elastically, that is return to its original dimensions after the applied pressure is released, it is obvious that the elastic limit at the bore must not be exceeded. If the problem is presented of designing a cylinder which will func-

tion elastically under a given pressure, two conditions can be varied; namely, the elastic limit of the material to be employed, and the wall thickness, assuming that the interior diameter must be some fixed dimension. There are certain quite definite limitations on the use of material having a high elastic limit, particularly in large cylinders. A certain ductility must be present in the



$$St = \frac{2}{3}\,\frac{P_0 R_0^2 - P_1 R_1^2}{R_1^2 - R_0^2} + \frac{4}{3}\,\frac{R_0^2 R_1^2 (P_0 - P_1)}{R_1^2 - R_0^2}\,\frac{1}{r^2}$$

Fig. 1—Distribution of Stress in the Cross Section of a Cylinder Having 1 Caliber Wall Thickness. The Actual Intensity of Stress at Any Radius is Plotted as Ordinates.

material so that disastrous failures will be avoided in event the cylinder is ruptured by an abnormally high pressure. Furthermore, the thickness of the cylinder wall itself may make the obtaining of a high elastic limit an impossibility. Likewise, increasing the thickness of the cylinder wall beyond a certain amount does not materially increase the elastic strength of the cylinder. In Fig. 2, the strength of a series of cylinders is shown having different ratios of outside and inside diameter. The diameter ratio is plotted as the ordinate, and the strength of the cylinder expressed as a percentage of the elastic limit of the material from which the cylinder is made is plotted as the abscissa. From the very nature of this curve, it is obvious that beyond one caliber thickness of wall further increases of thickness produce very little effect upon the elastic strength. Certainly the greatly increased weight

brought about by increasing the wall thickness beyond a 3 to 1 diameter ratio is distinctly out of proportion to any increase in elastic strength.

The realization of this condition has made it obvious that if any means could be devised to place the metal in the bore under

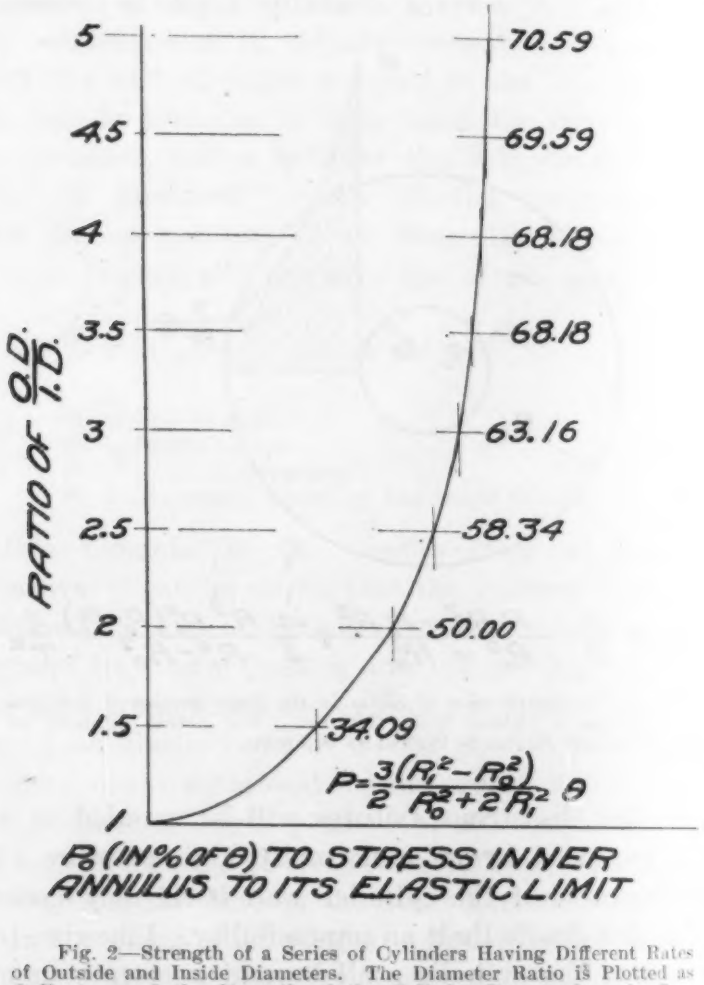


Fig. 2—Strength of a Series of Cylinders Having Different Rates of Outside and Inside Diameters. The Diameter Ratio is Plotted as Ordinates, and the Strength of the Cylinder Expressed as in Percentage of the Elastic Limit of the Material is Plotted as Abscissæ.

compression tangentially, with the cylinder at rest, or when no pressure is applied, an increase in strength could be obtained. It is obvious that if the metal in the bore could be compressed to its elastic limit in compression, the elastic range of the cylinder would be doubled. If, for example, the elastic limit of the material was 50,000 pounds per square inch, a total elastic range would be available of 100,000 pounds per square inch, if 50,000 pounds elastic limit could be realized in compression. Several methods

have been tried to produce this desired compression in the metal at the bore, but in practically all cases the cylinder no longer remains a simple one.

Every one is familiar with the compound cylinder in which a certain amount of compression at the bore is secured by shrinking cylinders, one upon the other. In the construction of artillery, this method has been extensively followed. There are several serious disadvantages to this plan of construction, the principal ones being the accurate machining required in preparing the cylinders for the shrinkage operation which results in an expensive type of construction, and the additional time and equipment involved in the operation adds further expense. Another method which has been employed in obtaining initial compression at the bore of a hollow cylinder is to wrap it with a number of layers of wire, the wire being applied under either a uniform or a variable tension. This method has also been employed in the construction of artillery, and in reality such a compound cylinder is an assembly of a number of very thin cylinders. Both of the described methods for increasing the strength of hollow cylinders are essentially mechanical ones. Other schemes have been attempted from time to time, and the one employed by Captain Rodman, about 1850, is of particular interest. In that period the cylinders employed in gun construction were of cast iron, and it was the belief of Captain Rodman that if the cooling of the casting could be so conducted that the interior would chill first an ultimate compression of the metal adjacent to the bore would occur, thus producing an increased elastic strength. By a very ingenious system of water cooling the core of the casting, he was able to put his theory into effect with very satisfactory results.

Although, theoretically, this method was satisfactory, its application presented many difficulties due to the impossibility of securing a satisfactory degree of uniformity in the cooling operation. In some cases, the castings burst spontaneously on cooling, and in other instances failed when the machining operation was started. Another system, however, is available by which an initial compression of the bore can be obtained in a hollow cylinder. In this process, the bore is intentionally stressed beyond the elastic limit and when the applied stress is removed the metal at the bore will be found to be in a state of compression, whereas the metal at the outer annulus of the cylinder will be in a state of tension. This

idea is not new, nor is its application to cylinder construction novel. The necessary overstraining has been obtained in several ways by different investigators. Mandrels have been forced through the bore of cylinders, increasing their size; corresponding results have been obtained by explosive effects; but the most easily controlled and least cumbersome method is to swell the cylinder hydraulically.

After a cylinder has been permanently expanded, the elastic conditions within its wall vary from tangential compression near the bore to tangential tension on the outside of the cylinder. This phenomena has been given careful mathematical analysis by several authorities, but when it was desired to compute the elastic strength of cold-worked cylinders after different amounts of enlargement, a satisfactory method which would give any reasonable results was not available. In analyzing the conditions existing in a cylinder which has been subjected to cold working, it is obvious that in addition to the compression existing at the bore another source of additional elastic strength is present. If the bore of such a cylinder has been enlarged 6 per cent, for example, the outer wall will also have been enlarged, but by a lesser amount depending upon the thickness of the cylinder wall. This enlargement is equivalent to a tangential stretching of the metal, and the original elastic limit is elevated to some new figure, depending upon the amount of stretch in the various elements of the cylinder wall. It is obvious that the maximum elevation of the elastic limit will occur at the bore of the cylinder.

Therefore, in determining the strengthening effect imparted by the cold working operation, it is necessary to take into account not only the compression of the metal at the bore but the elevation of the elastic limit as well.

In the course of experimental work at Watertown Arsenal, several cold-worked cylinders have been examined to determine the condition of strain existing in the various elements of the wall. Fig. 3 shows the conditions existing in a cylinder having a bore of 6 inches and an outside diameter of 18 inches, after it had been enlarged 6 per cent in the bore by a hydraulic pressure of 86,000 pounds. Tangential stresses have been plotted as ordinates along the cylinder wall, and the actual amount of compression at the bore was found to be 35,000 pounds per square inch. The values plotted in this graph were obtained by removing a series of thin

strain rings from a section of the enlarged cylinder. When the thin rings were removed from the bore of a cylinder, an enlargement of the ring occurred; when removed from the outer portion of the cylinder wall, contraction would take place. Series of rings have been removed from such cylinders, starting from the inside and working towards the exterior, and also starting from the exterior and working towards the interior of the original cylinder, and in every case the results were in good agreement.

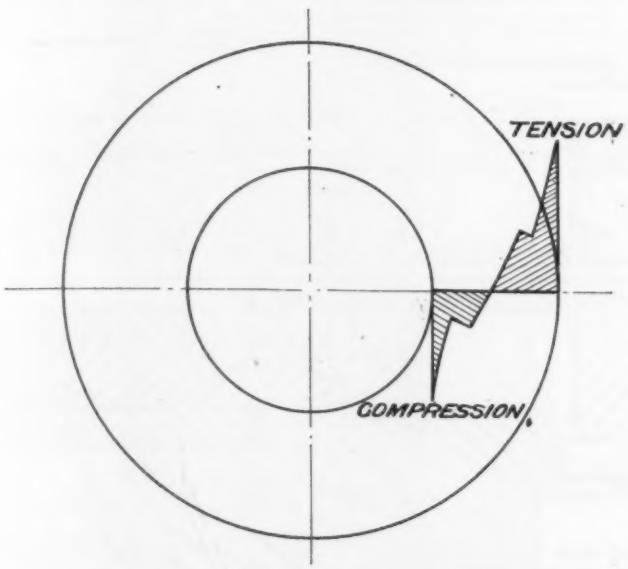


Fig. 3—Condition Existing in a Cylinder Having a Bore of 6 Inches and an Outside Diameter of 18 Inches After It had Been Enlarged 6 Per Cent in the Bore by a Hydraulic Pressure of 86,000 Pounds Per Square Inch.

As the amount of compression at the bore never in any instance accounted for the increase in elastic strength of cold-worked cylinders, it was obvious that the increase of the elastic limit of the metal, due to cold working, was a very prominent factor in the result. As at least two variables were present, it was decided that the best method of procedure was to select a number of cylinders having different interior and exterior diameters, and to actually determine by experimental means the elastic strength after different amounts of enlargement had been given the several cylinders.

As the apparatus employed in this experimental work may be of some interest, the essential items will be described. As the actual pressures necessary for testing some of the experimental cylinders was in the vicinity of 150,000 pounds per square inch, it was necessary to design an intensifier for the generation of this

pressure from the low pressure delivered by the pump. The intensifier is very simple in construction as is shown in Fig. 4. Low pressure water is delivered through the bottom of the intensifier and acts on the face of the moving piston. The water which fills the interior chamber of the piston is compressed against the ram, the high pressure water being delivered through a small hole in the

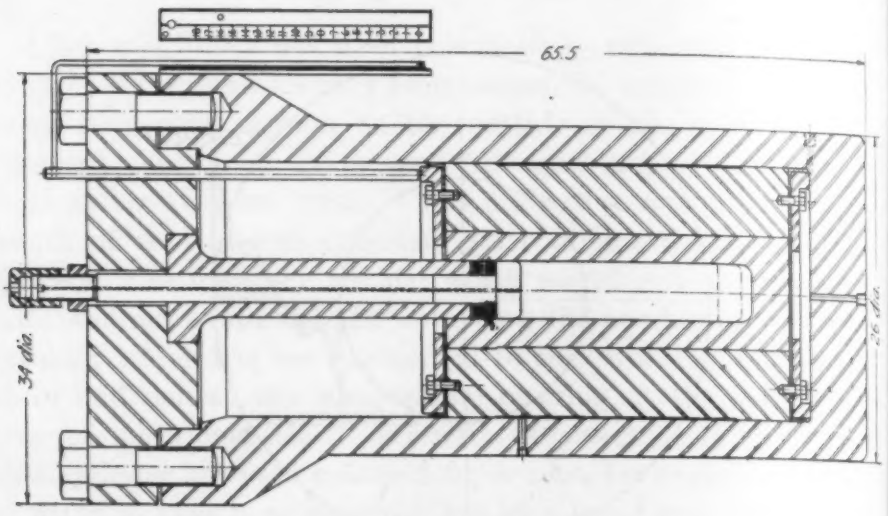


Fig. 4—Sectional View of Hydraulic Intensifier Used in Auto Frettage Work. The Ratio of Intensification in this Apparatus is 19.7 to 1.

ram stem. The ratio of intensification in this apparatus is 19.7 to 1. The high pressure water produced by the intensifier is led to the cylinder under test through high pressure piping and a suitable valve control. The most difficult problem encountered was to confine the high pressure to the bore of the cylinder while it was being enlarged.

The first type of packing utilized consisted of a solid steel spool drilled out in such a way that water could be led into one end and out through the center of the spool about midway of its length through an outlet at right angles to the inlet. (See Fig. 5.) The body of the spool was turned down sufficiently to accommodate a seamless rubber envelope which was slid into place over one end of the spool in such a manner that a small hole in the rubber envelope engaged with the outlet in the middle of the spool. The ends of the rubber envelope were protected by rubber packings as shown in Fig. 5 previously referred to. When this unit was placed in the bore of a cylinder and connected with the intensifier,

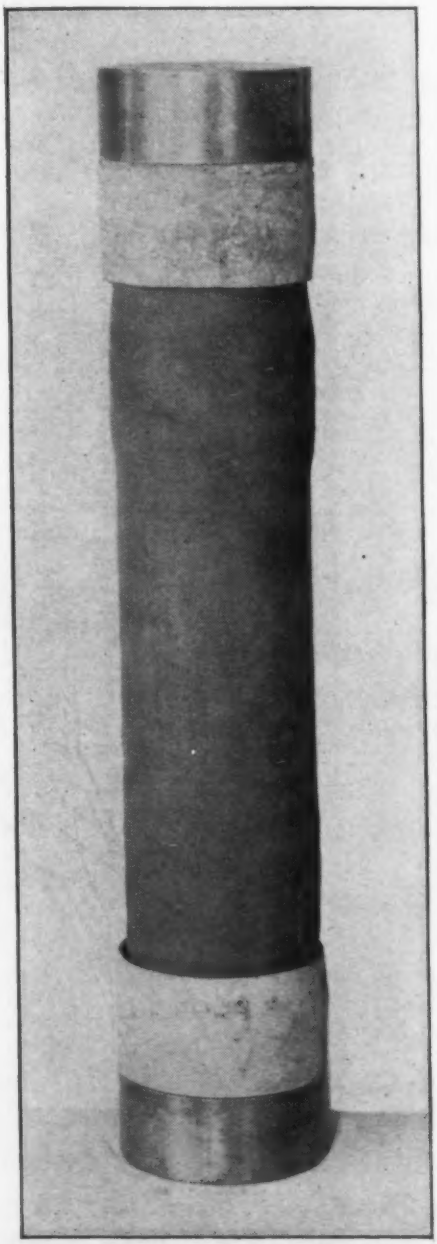


Fig. 5—Solid Steel Spool-Type of Packing Which was Drilled Out in Such a Way That Water Could be Let Into One End and Out Through the Center About Midway of Its Length Through an Outlet at Right Angles to the Inlet.

the admission of water caused an immediate swelling of the rubber envelope. The swelling continued until the envelope came in contact with the cylinder walls, the pressure of the water against the cylinder being entirely transmitted through the rubber of the

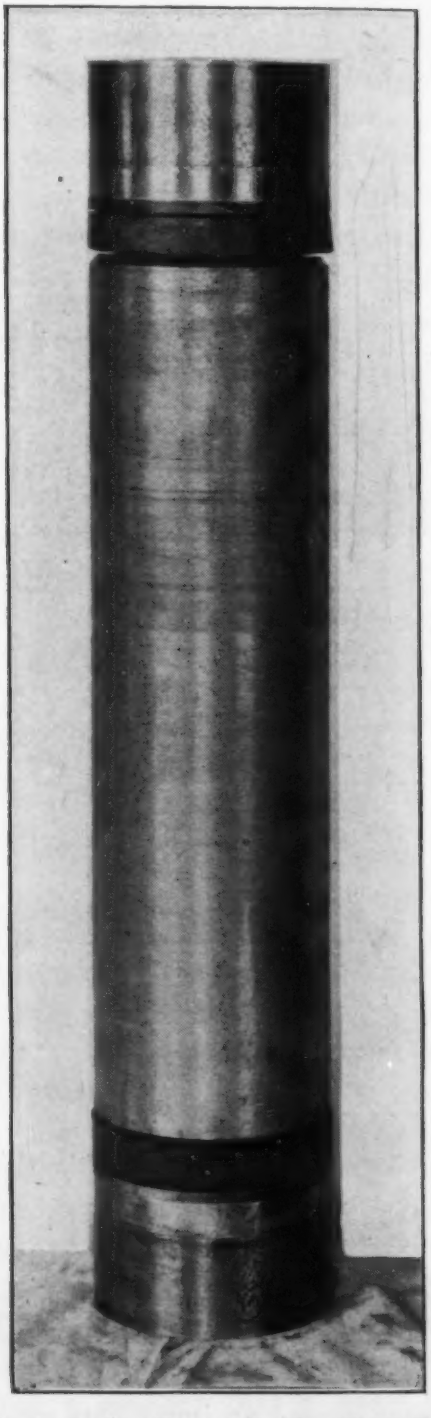
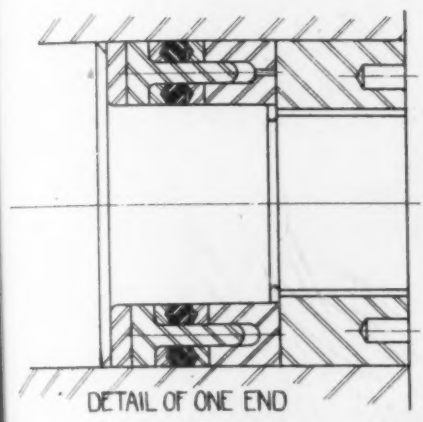


Fig. 6—Another Type of Packing Which Permitted the Use of Much Higher Pressures. The Solid Steel Spool is Similar to the One Shown in Fig. 5, Although the Water was not Confined in the Interior of a Rubber Envelope. Leather "U" Packings Were Employed at the Ends of the Spool, These Packings Being Supported by Means of Split Washers Resting on Conical Seats. This Packing Worked Satisfactorily Up to Pressures of 65,000 Pounds Per Square Inch.

envelope. This arrangement was used on cylinders having bore diameters from 3 to 9.5 inches, but was not satisfactory at pressures of more than 45,000 pounds per square inch.

A second design was made which permitted the use of much higher pressures, and is illustrated in Fig. 6. The solid steel spool was practically the same as in the previous type (Fig. 5),

ASSEMBLY



RING TYPE OF PACKING

LIMIT OF PRESSURE THAT COULD BE STOOD BY THE RUBBER ENVELOPES WAS = 45000 #□", APPROX.
LEATHER CUP PACKINGS = 65000 #□" APPROX.
RING TYPE IS LIMITED ONLY BY THE STRENGTH OF THE MATERIAL FROM WHICH THE SPOOL IS MADE.

Fig. 7—Sketch Showing the Ring Type of Packing. This Packing is so Constructed That the Higher the Pressure in the Bore of the Cylinder Being Enlarged, the Greater is the Intensified Pressure on the Packing Rings.

but the water was not confined in the interior of a rubber envelope. Leather "U" packings were employed at the ends of the spool, the "U" packings being supported by means of split washers resting on conical seats. This arrangement worked satisfactorily for pressures not exceeding 65,000 pounds per square inch, but beyond this limit its functioning was not certain.

A third modification has been made which is entirely satisfactory, and no pressure has yet been generated which has caused a packing failure. In this type of packing, illustrated in Fig. 7, the leather "U" packing has been removed and a series of concentric metal and rubber rings substituted. This packing is so constructed that the higher the pressure in the bore of the cylinder being enlarged, the greater is the intensified pressure on the pack-

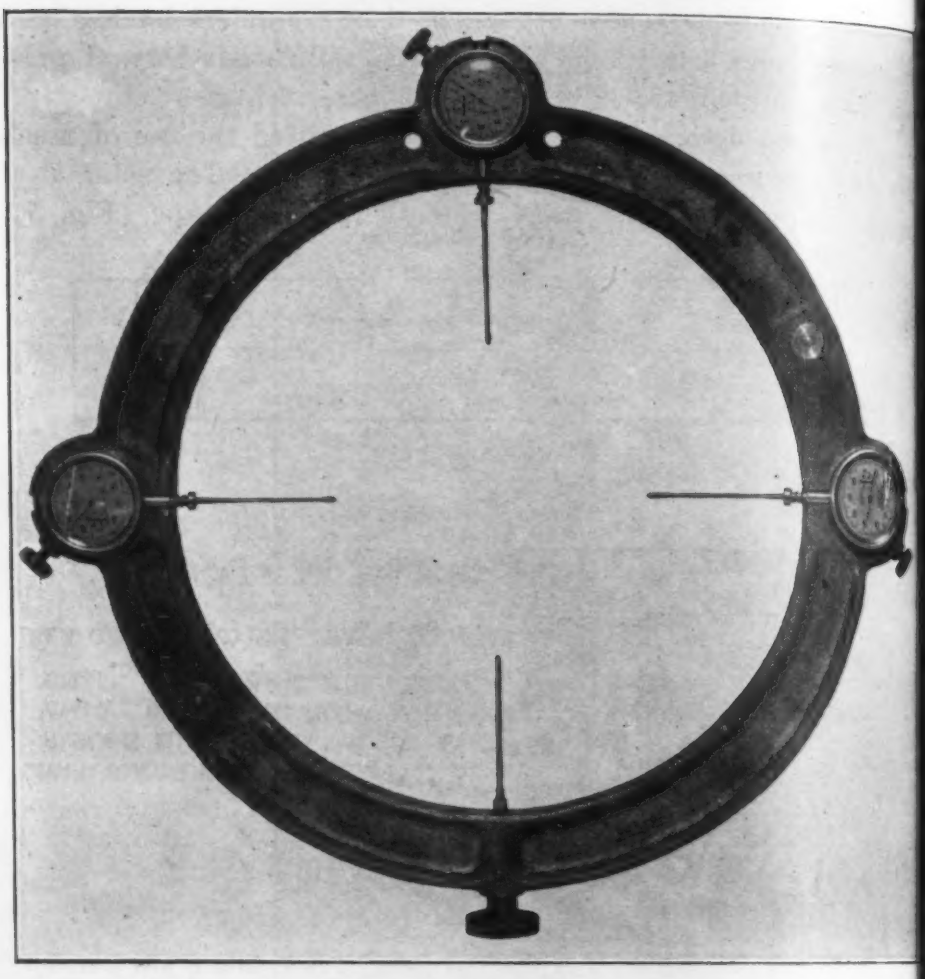


Fig. 8—Arrangement of One of the Individual Dial Gage Holders Used Throughout These Experiments.

ing rings. The same general type of packing is used in the intensifier.

The packing problem having been satisfactorily solved, the original experimental program consisting of stressing a number of cylinders both within and beyond the elastic limit, and recording for the several pressures applied the extension of the cylinder at several diameters, was then undertaken. In order to accomplish these measurements, the cylinders had holes drilled to different depths within their walls, and the diameter changes at these points were observed as well as the changes of diameter at the outside surface. Fig. 8 shows the arrangement of one of the individual dial gage holders used throughout the experiments. Fig. 9 shows

a cylinder having an 8 inch bore and an 8 inch wall thickness assembled for test. Five gage holders are in position for following the diameter changes, as well as an additional holder with three dial gages at each end for following the changes in length. The gages used register directly to a 0.0001 of an inch. Using this assembly, a number of cylinders were tested having interior

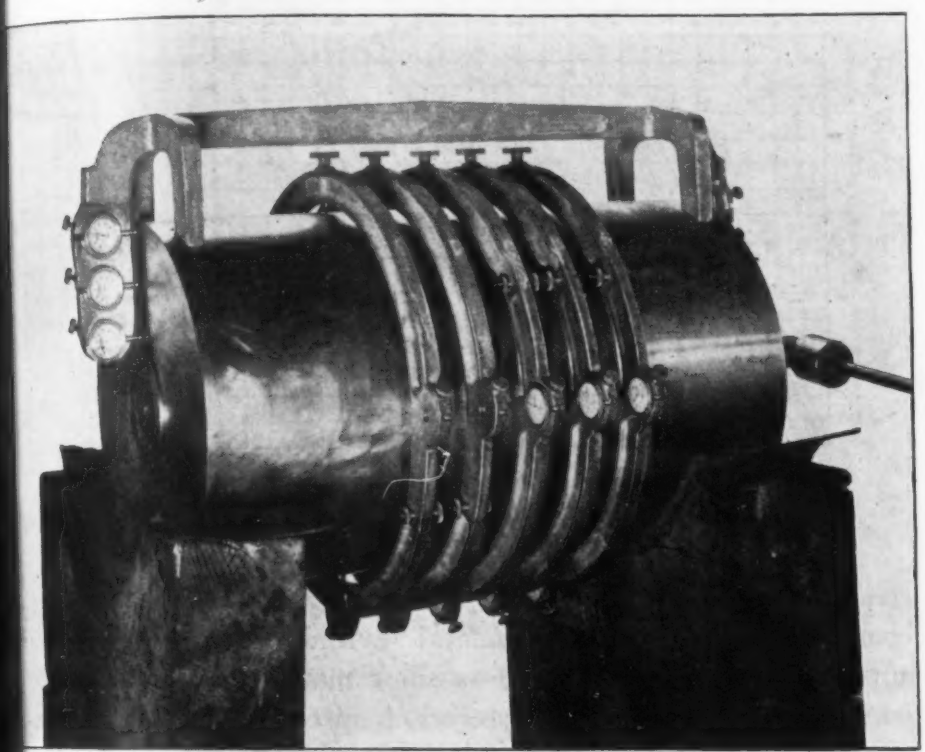


Fig. 9—Cylinder Having an 8-Inch Bore and an 8-Inch Wall Thickness Assembled for Test.

diameters varying from 3 to 9.5 inches, the final enlargement of the bore in some cases being as high as 30 per cent. From the observed movements of the several diameters under different pressures, curves can be plotted similar to the typical example in Fig. 10, which shows the movement of a 6 inch bore cylinder having a 6 inch wall thickness at a point 0.25 inch from the surface of the bore. Examining this curve, it will be observed that the cylinder behaves elastically until a pressure of 46,000 pounds per square inch is reached. At pressures higher than this, permanent sets will be observed when the maximum load has been removed. The testing of this cylinder was discontinued when a maximum pressure of 88,000 pounds per square inch had been reached and at which point

a permanent enlargement of the bore of 2 per cent had occurred.

After this enlargement, it was found that the cylinder functioned elastically at a pressure of 86,000 pounds per square inch, which is an increase in the original elastic strength of 40,000 pounds. At different enlargements of the bore, the new elastic

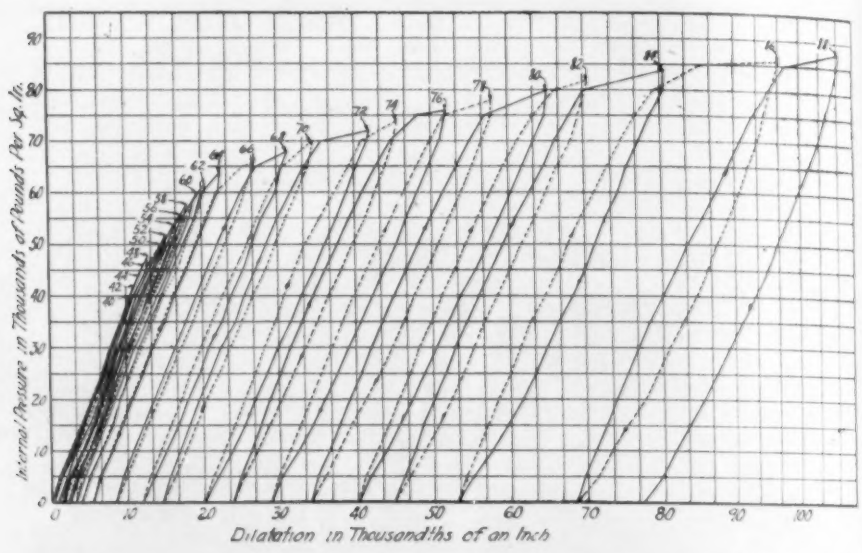


Fig. 10—Curves Showing Successive Dilatations of a 6-Inch Bore Cylinder Having a 6-Inch Wall Thickness at a Point 0.25 Inch from the Surface of the Bore.

strength was determined and this observation was made on the complete series of experimental cylinders. The stress-strain curves of the various cylinders show many points of interest, a particular one being the hysteresis loop obtained by loading and unloading a cold worked cylinder. Considering the illustration in Fig. 10, the behavior of this cylinder after a load of 88,000 pounds had been applied is typical. For convenience in following the complex curve of Fig. 10 every other set of loading and unloading valves are plotted as solid lines while the alternate ones are plotted as dotted lines. Alternate loadings and unloadings at this pressure materially reduce the area of the hysteresis loop and the cylinder in question would become perfectly elastic for all practical purposes at a pressure of 88,000 pounds per square inch. A similar result apparently occurs when cylinders are allowed to age or when they are subjected to low temperature annealing operations.

After the complete series of tests had been completed, it was found that with a steel in a certain condition a given percentage

enlargement of the bore resulted in a new elastic strength which was apparently not affected by the mass of metal in the cylinder wall as long as the ratio between inside and outside diameter was a constant; that is a cylinder having a 3 inch bore and a 9 inch outside diameter has the same elastic strength after a given enlargement as a cylinder having a 6 inch bore and an 18 inch out-

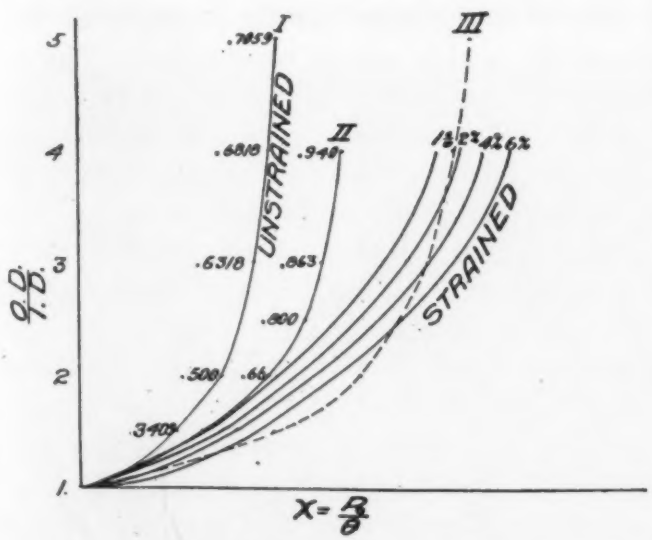


Fig. 11—Elastic Strength Curves Showing the Amount of Permanent Enlargement Necessary When Constructing a Cold Worked Cylinder in Order That It May Withstand a Certain Internal Pressure.

side diameter, assuming, of course, that they were made from the same grade of steel. It is, therefore, possible for any grade of steel to construct a series of strength curves for different percentages of bore enlargement. Such a series of curves is shown in Fig. 11. There is also shown in this figure the elastic strength of a simple cylinder and the elastic strength of a compound cylinder made of two elements. Certain features of these curves may be of interest.

Examining the case of the cylinder having a 3 to 1 ratio, that is an outside diameter three times as great as the inside diameter, the elastic strength of such a cylinder will be found from the accepted formula to be 0.63 times the elastic limit of the steel from which the cylinder is constructed. If a compound cylinder of two layers was constructed in the most ideal fashion using the most favorable shrinkage, the strength of such a unit would be 0.86 times the elastic limit of the material from which the cylinders

were made. If a compound cylinder were made of an infinite number of layers with the most ideal shrinkage conditions, its elastic strength, assuming the same diameter ratio, would be 1.26 times the elastic limit of the steel from which the cylinders were made.

Examining the strength curves of the cold-worked cylinders, it will be found that a 3 to 1 cylinder with a 4 per cent bore enlargement will have the same elastic strength as the most ideal compound cylinder which can be constructed. The curves of the over-strained cylinders can readily be used in the proportioning of a cylinder which is to withstand a certain interior pressure. Assuming that a steel is available having an elastic limit of 50,000 pounds per square inch, and having decided upon the permanent bore enlargement which will be used, the ratio of interior diameter to exterior diameter can readily be determined from the strength curves. Although equations can be developed which fairly accurately represent such strength curves, the constants in these equations vary with the steel employed. In actual practice in design work, it is the custom to proportion a pressure containing vessel from curves such as those which have been illustrated.

Everyone is familiar with the fact that the stress-strain curve beyond the elastic limit in an ordinary tensile specimen varies with the nature of the material and its previous treatment. The stress-strain curve of a cylinder subjected to pressure similarly varies, and the strength curves obtained for a 3.50 per cent nickel steel with approximately 0.40 per cent carbon so heat treated as to have an elastic limit of 65,000 pounds per square inch will not be the same as a strength curve of some other steel having the same physical properties but being in a different structural condition.

In the construction of a cylinder by the cold working process to withstand a certain internal pressure, the necessary amount of permanent enlargement which it is necessary to give the cylinder in order to obtain the desired elastic strength can be determined from the strength curves illustrated in Fig. 11. It is obvious that the movement at the bore can be most readily followed by the movement of the outside diameter. Devices can be constructed and are in use for following the movement of the bore while the cylinder is being subjected to the cold working process, but they are very complicated and could not be classed as shop appliances. It is very easy, however, from a series of observations to con-

struct a flow curve for different wall thicknesses showing the relative movement of the bore and exterior of a cylinder when stressed beyond its elastic limit. In a cylinder whose wall thickness is equal to the interior diameter an enlargement of the bore of 8 per cent is equivalent to an approximate enlargement of 1 per cent on the exterior diameter.

In the manufacture of pressure containing vessels, and particularly those whose outside diameter is not uniform, such as the case of a gun body, it is obvious that the obtaining of the desired amount of enlargement would not be a simple problem unless some limiting means could be devised for confining the enlargement to the desired amount. In the case of a gun, a pressure of 60,000 pounds might give the desired enlargement at the muzzle, whereas 100,000 pounds interior pressure would be necessary over the breech section. A method has been developed which involves the use of a container which limits the enlargement to the desired amount. Fig. 12 shows a gun manufactured by the cold working process as well as the container used to limit the amount of enlargement. It will be noted that the section at the muzzle of the gun (at the right of figure) is very much thinner than the section at the breech, and if a uniform pressure were applied throughout

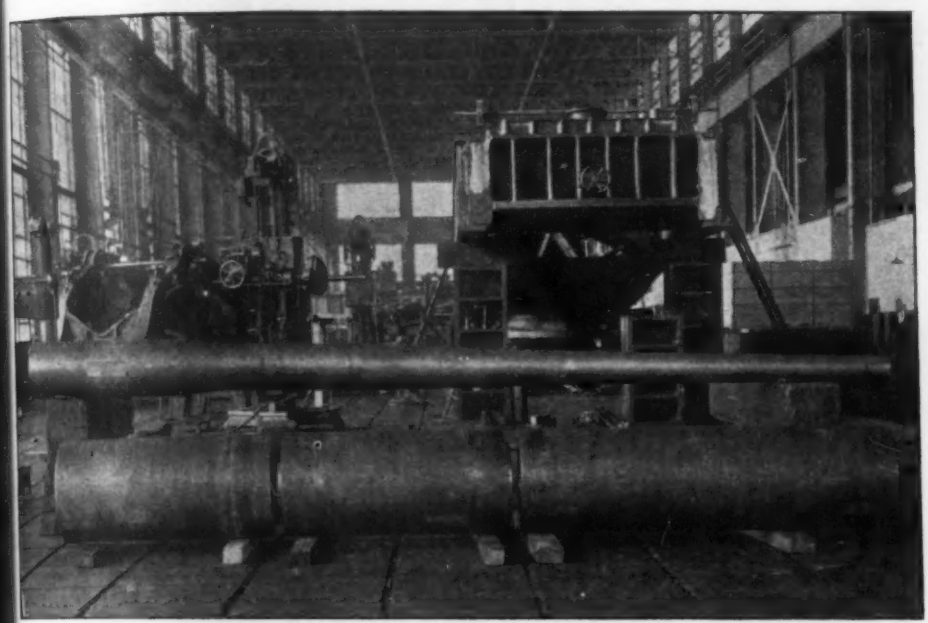


Fig. 12—Photograph of a Gun Manufactured by the Cold Working Process. The Container Used to Limit the Amount of Enlargement is Also Shown.

the bore the muzzle would be ruptured before the breech obtained the proper enlargement. A container is therefore constructed whose interior contour is so machined that each section of the gun will receive the proper enlargement, and after this enlargement has been obtained further expansion is prevented by the walls of the container. The same method can be sucessfully applied to thin wall cylinders having both an irregular exterior contour and wall thickness.

In the actual manufacture of guns by the cold working process, the general scheme is followed as illustrated in Fig. 13. The container is erected in a vertical position, the gun being lowered into place. Packings are provided at each end of the gun, the pressure being applied through the pump and intensifier previously described. The end pressure on the packings is held by tie rods which can be seen in Fig. 13. If it is desired to determine the pressure at which the various sections of the gun make contact with the container, this can be accomplished by means of small holes drilled through the walls of the container in which dial gages with extension points are placed, the gages being assembled in the frames as described by Fig. 8. During the period of actual enlargement of the gun, the indicators on the gages move very rapidly, but when contact is made with the container the rapid movement suddenly stops and becomes proportional to the applied pressure due to the elastic strength of the container walls.

Although in the majority of cases the container method makes it feasible to complete all of the external machining before the enlarging pressure is applied, it is necessary in the construction of guns to make a finish cut in the bore and complete the rifling operation after the enlarging pressure has been applied. It also occurs in some instances that a certain amount of metal must be removed from the exterior of a cylinder after the cold working operation has been completed. As the metal on the exterior of a cold-worked cylinder is under tension, whereas the metal at the bore is under compression, it is obvious that the removal of metal from either the outer or inner annulus will affect the strength in an entirely different manner than would be the case if the metal in the cylinder walls was not in a state of initial stress. In order to determine the effect upon the elastic strength produced by the removal of metal either from the inside or outside walls, two cylinders having a 3 inch bore and a 9 inch outside diameter were

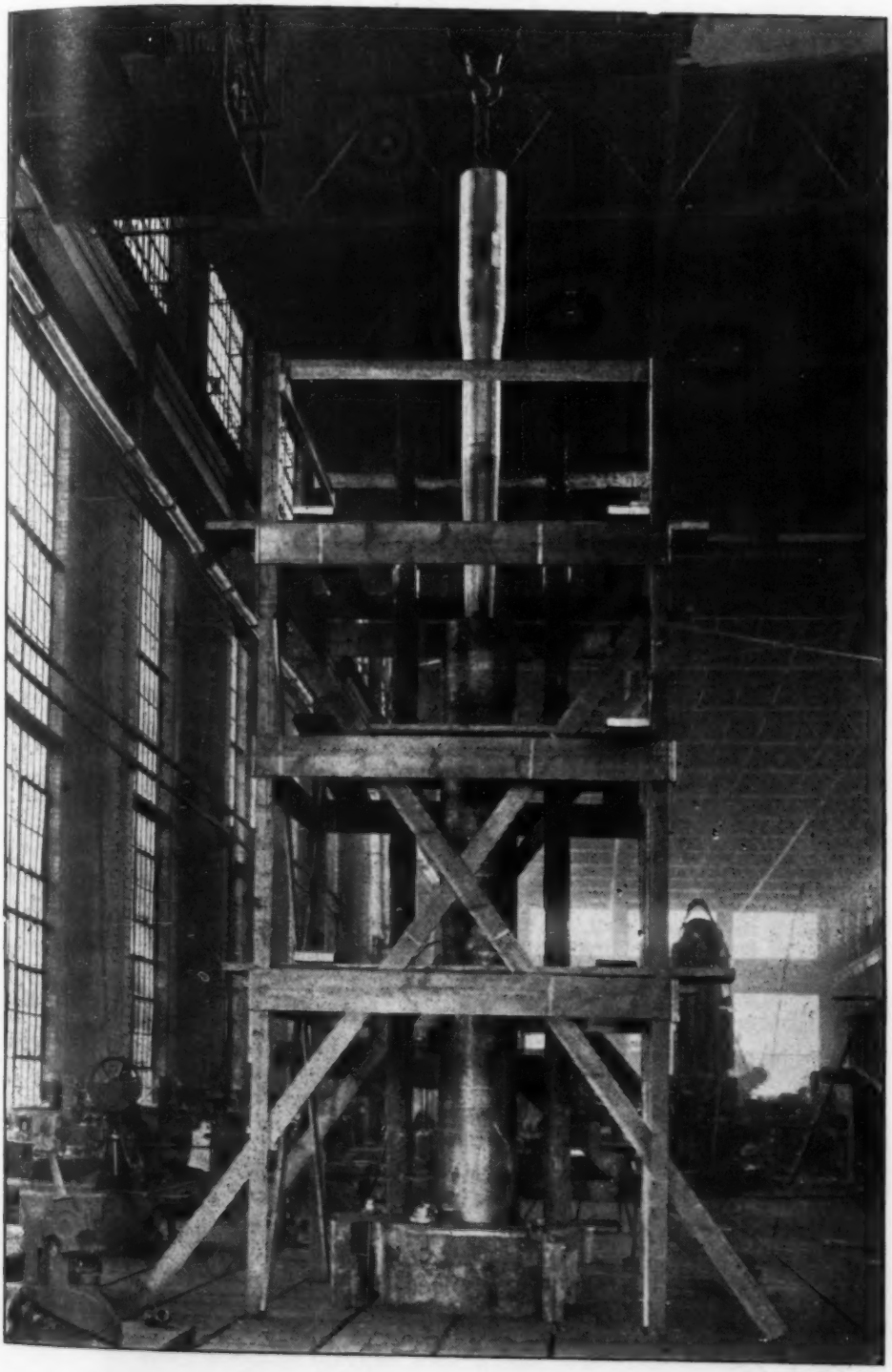


Fig. 13—Photograph Showing the Manner in Which the Actual Manufacture of Guns by the Cold Working Process is Conducted.

enlarged 5 per cent and then tested for elastic strength after different amounts of metal had been removed. Successive reductions in the diameter of one cylinder were made by removing 0.25 inch layers of metal from the outside wall, whereas in the second cylinder the bore was enlarged by successively removing 0.25 inch layers from the interior diameter. The general results obtained

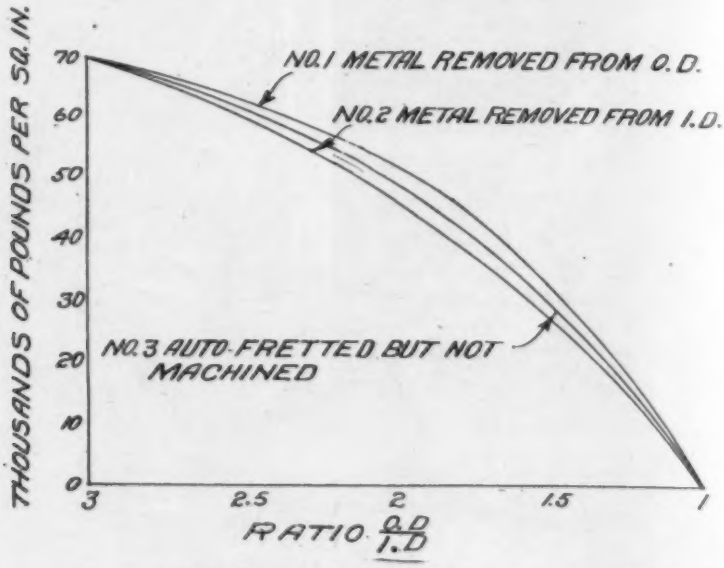


Fig. 14—Curves Showing the Effect Upon the Elastic Strength Produced by the Removal of Metal Either from the Inside or Outside Walls of Cylinders. Two Cylinders Having a 3-Inch Bore and a 9-Inch Outside Diameter were Enlarged 5 Per Cent and Then Tested for Elastic Strength After Different Amounts of Metal had Been Removed. Successive Reductions in the Diameter of One Cylinder were Made by Removing 0.25 Inch Layers of Metal from the Outside Wall, Whereas in the Second Cylinder the Bore was Enlarged by Successively Removing 0.25 Inch Layers from the Interior Diameter.

are illustrated in Fig. 14. The middle curve, No. 3, shows the strength of a series of cold-worked cylinders that had been enlarged 5 per cent having different ratios of outside and inside diameters. The lower curve, No. 2, shows the strength of a series of cylinders of the same outside and inside diameters as used in obtaining curve No. 3, but the cylinders in this instance were machined to the various wall ratios from a caliber thick, or 3 to 1 ratio cylinder, by removing metal from the bore. Curve No. 1 shows the strength of a series of cylinders, the various wall ratios being obtained by removing metal from the outside diameter. It is obvious from a study of these curves that the removal of metal from the outside diameter is less destructive to the elastic strength of a given cylinder than the removal of metal from the bore. Ex-

perience has shown that the data obtained in this experiment enables a fairly accurate computation of the strength of a cold-worked cylinder given a certain enlargement and then changed in dimensions by the removal of metal either from the interior or exterior.

Although small cylinders can readily be fabricated from single

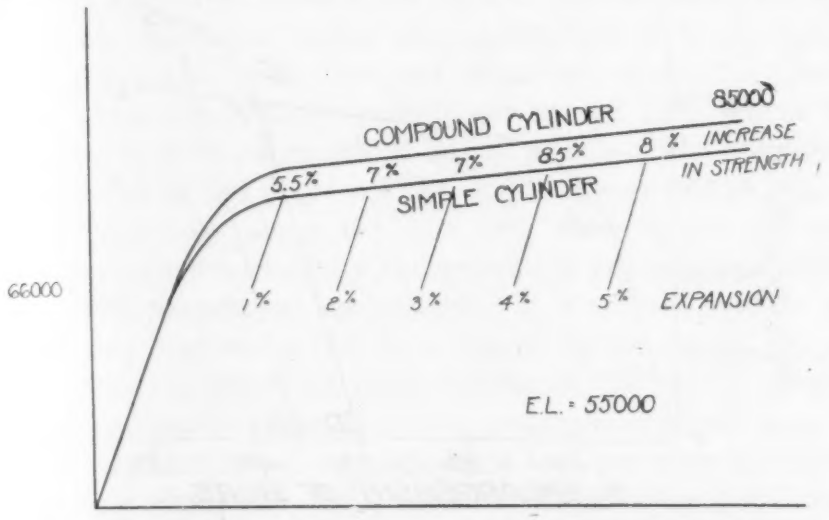


Fig. 15—Curves Showing the Increase in Strength Over Simple Cylinders by Expanding a Compound Cylinder.

forgings by the cold working process, thus avoiding the expensive operations of shrinkage or wire winding, a limit exists where it is not economical or feasible to construct either ordnance or other pressure containing vessels from one piece. A 16 inch gun, for example, could be given the proper elastic strength if made from a single forging, but the size of the forging would be such that is not believed the method would be practical.

The application of the cold working process to compound cylinders made up of two or more layers is entirely possible, and by the use of proper bore enlargements in the several layers the strength of such an assembly can be made higher than the elastic strength of a single forging having the same dimensions as the compound unit. If a compound cylinder having a bore of 3 inches and an exterior diameter of 9 inches is made up of two cylinders having the same wall thickness, that is 1.5 inch, and the outer cylinder is cold-worked before the assembly of the two units is made and then the final enlargement of the bore is given, the increased elastic strength resulting will depend upon the extra en-

largement applied to the outer layer. An illustration is given in Fig. 15. The cylinders used in this test had the dimensions previously given, and the outer cylinder was enlarged, before assembly, 4.25 per cent at the bore. The inner cylinder was then placed within the outer cylinder and pressure applied to the inner cylinder, enlarging its bore 6 per cent. The 6 per cent enlargement

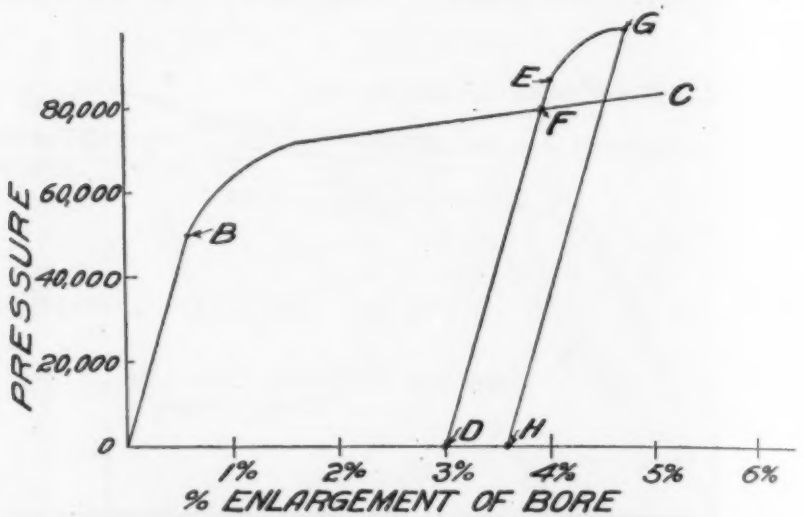


Fig. 16—Curves Showing the Effect of Various Annealing Operations on the Elastic Strength of Cylinders After Different Amounts of Cold Working had Been Applied.

of the bore of the inner cylinder produced an additional enlargement of 1.75 per cent at the inner bore of the outer cylinder. It is, therefore, obvious that when the bore of the inner cylinder had been enlarged 6 per cent, the bore of the outer cylinder had received the same enlargement. During the process of enlarging the inner cylinder after the assembly had been made, it was observed that at a 1 per cent enlargement the increased strength was approximately 5.50 per cent greater than the strength of a simple cylinder having the same dimensions. At 5 per cent, the increase in strength of the compound cylinder over a simple cylinder was approximately 8 per cent, and this ratio was unchanged at a 6 per cent bore enlargement.

If two cylinders are assembled with a good mechanical fit and no previous enlargement has been given the outer layers of the assembly, it will be found that the elastic strength of such a unit is practically identical with the elastic strength of a simple cylinder of the same dimensions.

During the course of experimental studies on both simple

and compound cylinders, attempts have been made to determine the effect of various annealing operations on the elastic strength after different amounts of cold working had been applied. One of the general results observed is illustrated in Fig. 16 where pressure is plotted as the ordinate, and enlargement of the bore as the abscissa. The cylinder under discussion behaved elastically up to a pressure of 50,000 pounds per square inch, represented by the point B on the curve. After an enlargement of 3 per cent had been made, the cylinder behaved elastically along the line DF up to a pressure of 80,000 pounds per square inch, which shows an increase in elastic strength of 30,000 pounds. The cylinder was then annealed at 482 degrees Fahr. (250 degrees Cent.), and then behaved elastically along the line DE, showing an increase in elastic strength produced by the annealing operation of approximately 7,000 pounds per square inch. It is not yet possible to say whether this increase is due to a change in the elastic properties of the metal, or whether a readjustment of the strains within the cylinder wall produced an increased compression at the bore. The cylinder was then given an additional half per cent enlargement, and behaved elastically along the line HG showing a still further increase in elastic strength. It will be observed that the increment in elastic strength produced by this additional 0.50 per cent enlargement after the annealing operation was much greater than the increment would have been if the cylinder had been enlarged from 3 to 3.50 per cent without an intervening anneal.

The shape of the curve EG is very similar to the shape of the original stress-strain curve just beyond the original elastic limit, located by the point B. The annealing operations at 482 degrees Fahr. (250 degrees Cent.) followed by additional increments of enlargement was continued at 6, 9 and 12 per cent bore enlargements. In general, it was observed that the increased elastic strength, produced by the low anneal applied, was less at the higher bore enlargements. Other annealing temperatures have been applied, the minimum being 248 degrees Fahr. (120 degrees Cent.) and the maximum 842 degrees Fahr. (450 degrees Cent.). The general effects of the lower anneals are similar to the anneal at 482 degrees Fahr. (250 degrees Cent.), although apparently less in magnitude. At 842 degrees Fahr. (450 degres Cent.), an actual lowering of the elastic strength occurs by the annealing operation, although the subsequent effect of slight additional enlargement is

very similar to those produced when cylinders are annealed at 482 degrees Fahr. (250 degrees Cent.). As previously indicated, the exact causes of the strengthening effect produced by certain annealing operations cannot be given at the present time.

Experiments are now in progress to determine whether the annealing operation produces a change in the strains present in the walls of the cold-worked cylinder, or whether the effect is due to a change in the elastic properties of the metal itself. It seems at the present time that both factors must be taken into consideration.

Although the cold working method for increasing the elastic strength of hollow cylinders has an application in ordnance construction, which results in a material saving of both time and money, it can readily be seen that the method is not restricted to this limited field. By the application of the container method, pressure containing vessels of almost any shape and contour can readily be produced. It, of course, follows that satisfactory high pressure generating apparatus is necessary to the process. Fluid pressures of 125,000 pounds per square inch can be easily generated and controlled, and high pressure apparatus is no longer on a laboratory scale.

As practical construction experience is attained, it will certainly be possible to handle higher pressures, even though a large volume of liquid under this pressure is necessary for any operation. It is impossible to predict in what fields such pressures will find practical application, but it is believed that industry in general will realize this possibility when it is found that the pumps and apparatus necessary are neither expensive nor difficult to handle and control.

Acknowledgments

During the course of the experimental work outlined in this report, the author has had the entire co-operation and support of General C. C. Williams, chief of ordnance, United States Army, and General T. C. Dickson, commanding officer at Watertown Arsenal. The author wishes to acknowledge their support in this investigation, and to express his appreciation of their great interest and assistance.

The experimental work described in this report has required for its completion the co-operation and assistance of the entire

staff of the metallurgical laboratories at Watertown Arsenal. The author wishes to particularly acknowledge the assistance rendered by Captain T. W. Conrad, Ordnance department, J. C. Solberg, engineer of tests, and Mary F. Dungan, secretary.

Written Discussion:—By Charles McKnight, Jr., The International Nickel Co., N. Y. City.

The work at the Watertown Arsenal by Dr. Langenberg and his associates on the cold working of hollow cylinders is of tremendous potential value in preparation for that inevitably recurrent, though regrettable, biological phenomenon—war. Bulwarked by our allies, supplied by them with munitions, we ended our participation in the last war after a year and a half of effort without having fired an American shell from an American field piece. The situation was little better in regard to other munitions, euphemistic statements to the contrary notwithstanding. It seems hardly probable that the good fortune of having such allies will be our lot in the next war—at least if the present feeling toward us can be taken as a criterion by which to judge.

We cannot then spend months in that state which might be termed "second-periphrastic" preparation—"about to be about to be getting ready" —and, since auto-frettage simplifies the production of gun tubes and shell, it should be a great factor toward the essential speed in munition manufacture. It replaces heat treating equipment, difficult to obtain, install and operate hurriedly, with a simple apparatus consisting of a motor, pump, a steel cylinder and what might be called a die. The process requires minutes against days and even weeks with the older heat treatment.

Second is its value in the field. After a 75-millimeter gun has fired a few thousand rounds its accuracy is so impaired through the destruction of the rifling that it can no longer be used for barrage and its value is much diminished for other kinds of fire, such as counter-battery, harassing and interdiction. The piece must then be sent back to the nearest ordnance depot which is fitted for re-tubing, probably many miles from the front, and a new piece issued to replace it. This involves a very large reserve of guns to replace those being repaired and, of no minor importance in these days when variations of the thermometer and barometer are incorporated in the firing data, requires that the gun crew familiarize themselves with the replacement gun, having different constants and characteristics. Now, with the adoption of auto-frettage it seems possible that spare tubes could be issued just as spare machine gun barrels are and the piece re-tubed near the front and returned in a very short time.

Another advantage from the manufacturer's standpoint is that this process probably will show up any serious defects in the steel. Under the stress of expansion it seems almost certain that any particularly weak spot will give way, thus causing the tube to be rejected before the expensive and time-consuming rifling and machining had been done. At present we aim to accomplish the same purpose by proof-firing, during which the gun is fired

so that the powder pressure is double the service pressure, by no means as severe a test as it gets under auto-frettage. This, furthermore, is done after the tube is finished and mounted in the carriage, so that if it fails a considerable loss of both time and money are involved.

The same remarks are true in regard to the manufacture of shells, with the exception of the advantage of easy replacement, because we always hope that by the time a shell reaches the enemy, it will be the enemy and not the shell which needs replacement. But on the face of it this process should render the shell wall sufficiently strong to resist the stresses occurring during firing, which are by no means small, and yet increase the fragmentation when the shell bursts, a desirable feature.

There seem to be two disadvantages. First, the ductility is much reduced and it is a question whether this may not be a serious disadvantage in gun tubes. The second is not a disadvantage but a lack of advantage; the auto-frettaged gun apparently shows no increase in resistance to erosion. Erosion constitutes probably the most serious problem in gun design today. With the field artillery calling for higher muzzle velocities to attain greater range—15,000 yards is now obtainable with a 75-millimeter gun—and the absolute requirements for higher velocities in anti-aircraft artillery, erosion cannot be disregarded. For example, an increase of only 25% in muzzle velocity of a certain piece of artillery resulted in decreasing the effective life of a tube by 90%; i. e. from several thousand rounds down to a few hundred rounds.

The use of alloys in auto-frettaged steel is promising only because it may be possible to resist this erosion more successfully and to some degree increase the residual elasticity of the metal. I think it is safe to say that, while no steel has shown satisfactory resistance to erosion, the nickel steels have more nearly approached the resistance desired.

Oral Discussion

JEROME STRAUSS: Mr. Chairman and gentlemen. I have heard portions of Dr. Langenberg's paper before and I know that what he has given us this morning is really only a very small part of the work that he has done. Unfortunately, too much of it cannot be spoken about, and there are things that I would like to say in this discussion if it were permissible to do so.

Dr. Langenberg has shown you the method that he has employed in the expansion of a tapered cylinder of uniform bore but of irregular cross-section. It has its advantages and it has its disadvantages. The exterior of that member, which is usually not machined to very small tolerances, must be machined with extreme care in order that the process shall be applicable. The fixture, you will appreciate, for a large member is extremely costly. Also, the covering up of existing soft spots may be an advantage and it may be a serious disadvantage. By this method you do not find them, and perhaps you want to know where they are.

Another method that has been employed, which, incidentally, has both advantages and disadvantages—few methods in anything that we have to work with cannot be picked apart—is to use an inner bar, or a spool, as Dr. Langenberg has referred to, but not to use any outside fixture, and instead,

to apply a series of straps, between the ends of each of which is set up an Ames dial. The expansion is controlled by observing the elastic movement; as the author has shown, the compression is not generally carried to a point where inelastic movement occurs at the outer fiber. With a tapered outside surface and a cylindrical inside surface, there are, of course, with uniform internal pressure, differences in the stressing of the metal at different points along the length of the cylinder. Hence, it becomes necessary to expand one portion of the length, release the pressure, then expand a second length unit, and so on, making the length units as long as is consistent with not too great a variation in the final properties of the cylinder. The method has the further disadvantage that the design of the packing must be given considerable attention, so that the pressure shall tend to tighten it against the inner wall, because, as Dr. Langenberg has intimated, serious accidents are possible should part of the equipment give way. I have seen such accidents, which fortunately, have not resulted in any loss of life. It is important, however, that by this method irregularities in the structural condition of the metal become very apparent.

T. D. LYNCH: It is very interesting for me to listen to this paper by Dr. Langenberg, which is really one of the most pioneer papers that has been prepared and presented to this body for some time. It is along a line with which few people are thoroughly familiar. It is a technical discussion of most difficult form and has been given to us in a most receivable manner. His demonstrations and illustrations have been such as to express to us the most difficult formulas in a practical manner.

I wish to say that I have seen some of Dr. Langenberg's work and some of his equipment and I know how carefully he has gone into it and how important it is to all of us.

There is one point that I would like to touch on also in connection with this practice of increasing tensile properties of metals by stressing, annealing and then re-stressing. Several years ago I had occasion to make such a series of tests on wire. This wire (about 0.45 per cent carbon) had a tensile strength of about 150,000 pounds per square inch under its first test. By repeated stretching and annealing, stretching again and annealing, although at a low temperature, the tensile strength was brought up to 405,000 pounds per square inch. This shows the possibilities of increasing the qualities of steel by work and by low heat treatments. Dr. Langenberg has shown how it is being made practical use of in the manufacture of our guns.

CHAIRMAN SAUVEUR: I might just say a few words in regard to that extremely interesting phenomenon of great strength and hardness and elastic limit resulting from annealing cold-worked steel, from annealing it up to what we generally call the blue heat range, some 250 or 300 degrees Cent. I had an occasion to investigate that phenomenon at Harvard and we did find exactly what Dr. Langenberg has told us, the great increase of strength, a great increase of elastic limit and hardness, by annealing to the blue heat range previously cold worked steel. Apparently we have no explanation for that phenomenon.

A METHOD OF MANUFACTURING LARGE RING FORGINGS

By W. L. Blankenship

Abstract

This paper presents a unique method for the production of large ring forgings when using a forging press or steam hammer having insufficient space between the supporting columns to accommodate the forging.

The author has described the method employed in the production of an 8-inch, 56-caliber training circle forging starting with a split I-Bar. The method of bending, opening and finish forging is described. The various operations are also shown in the illustrations. The method of heat treating the finished forging is described.

IN many lines of engineering effort, limitations of available equipment and the absolute necessity for performance of jobs that at first sight appear impossible, are ultimately responsible for the development of peculiar yet effective production methods. In the present case the specifications called for the manufacture of rings 12 feet in diameter, whereas the largest available forging press had a headroom of only 7 feet. One series of rings were to be used for internal gears and required a rough forging 5x11 inches in cross-section. The other series, of approximately the same diameter, were to be used for ball races and required a rough forging 4¼x6½ inches in cross-section. The physical properties that were specified were such that the first group could be made from a 0.35 per cent carbon, 3.50 per cent nickel steel, and the second group from a 0.45 per cent carbon, 2.50 per cent nickel, 1.25 per cent chromium steel, requiring in each case finishing with a thorough anneal followed by moderately slow cooling. It is obvious that these rings could not be manipulated for other forms of heat treatment, at least not without expensive and cumbersome equipment.

In the usual or standard forging practice, the manufacture of ring forgings is confined to two methods of operation which

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A paper presented before the Washington Chapter of the Society. The author, W. L. Blankenship, is forge shop superintendent, U. S. Naval Gun Factory, Washington, D. C.

might be described as follows:—First, for large rings where iron or a low carbon steel is suitable for the purpose intended, the usual method of manufacture is to forge or roll a bar to the desired length and dimensions, bend or roll it into a circle and then weld it. Where the specifications will not permit welding, or where the material is not readily weldable, the usual method is to shape up a cylindrical disc, bore or stamp a hole through it, put it on an arbor or mandril supported at both ends under a steam hammer or forging press and forge by rotating the forging on the mandril until it has been expanded to the desired diameter. This method of operation is shown in the Fig. 1.

It was apparent that neither of these methods could be applied to this project, as the material specifications required steels not readily weldable by the ordinary processes and also because the forgings would not comply with specifications if fused together by the acetylene or electric process. The second or more common practice in forging rings from solid discs could not be applied, as these rings were approximately twelve feet in diameter, while the opening in the largest available furnace was less than six feet wide and the maximum operating head room of the forging press was about seven feet; therefore in order to successfully consummate this project it was necessary to proceed along new and unusual lines.

After a series of experiments on a small scale, and intensive study of this project, plans were perfected which are believed to be unique in forging practice; the execution of these plans in order of operations follow:—

(a) For the first group of forgings 6-ton nickel steel ingots were used—Fig. 2; these ingots were approximately twenty-six inches in diameter. In the first operation the ingot was forged down and shaped into a large loop eye-bar as shown on sketch—Fig. 3, body dimensions being about 26 inches wide and 5 inches thick; the ends were considerably heavier, intended to permit additional forging after the ring had been partially formed, the length of the piece being slightly less than one-half of the circumferential length of the ring. This was necessary in order to permit the ends being shaped up to the finished dimensions of the section without making the ring too large.

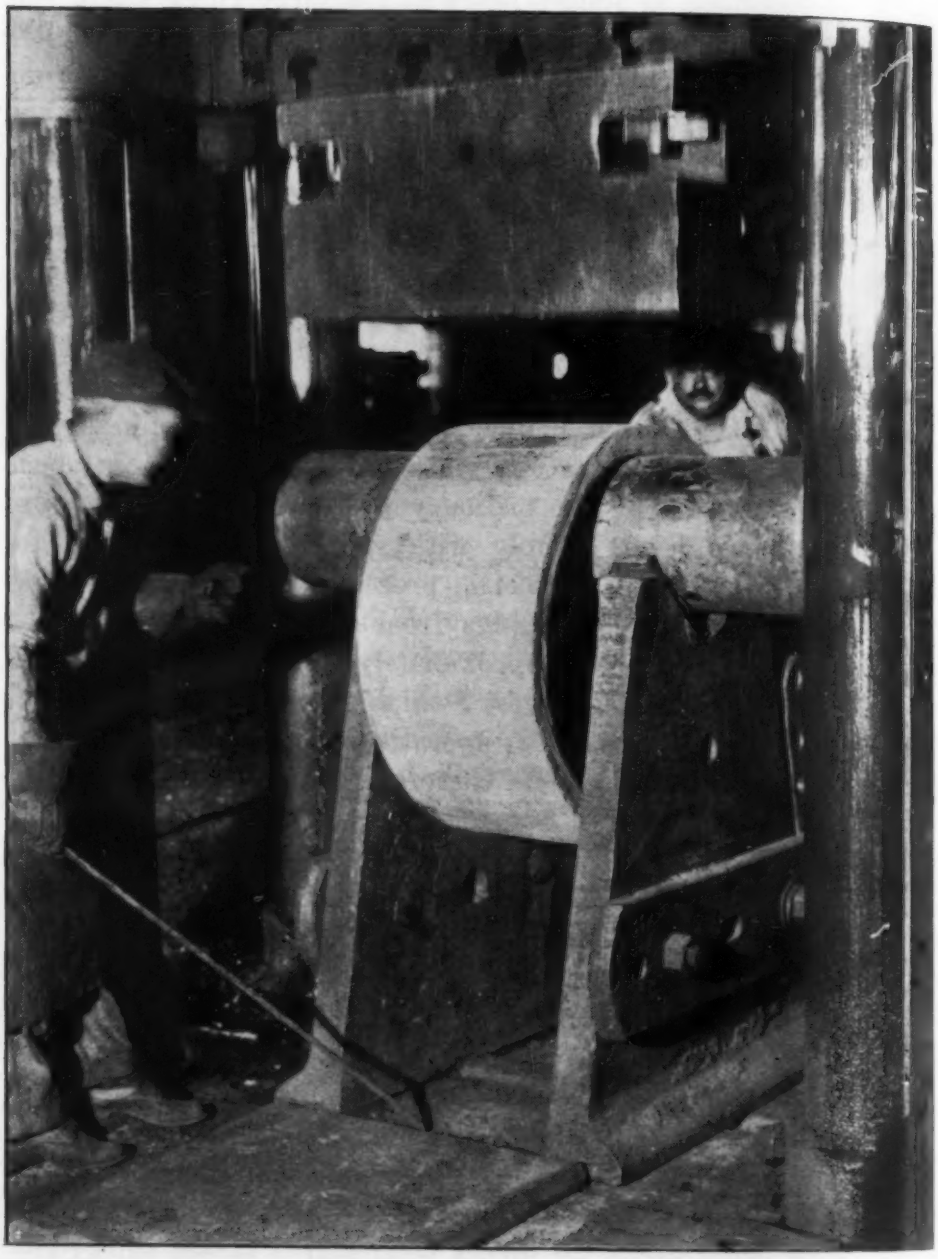
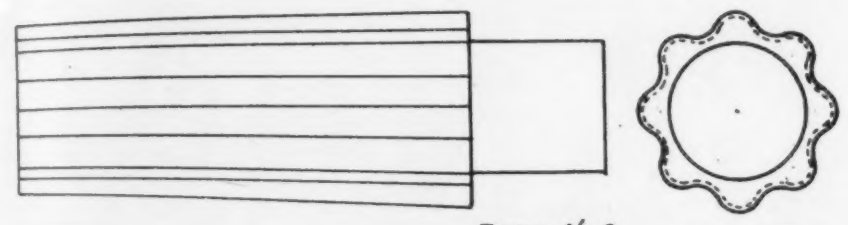


Fig. 1—Manufacture of a 14-inch Locking Ring. This Ring was Made by Piercing a Disc and then Subsequently Expanding it on a Mandril.

(b) The next step was to split the eye bar as shown in Fig. 4. This was done on the first forgings made, by heating in sections and hacking hot; later it was found to be more economical and satisfactory to have them slotted on a planing machine.

(c) The link-shaped piece shown in the sketch—Fig. 5, was obtained by heating the ends of the slotted bar and forcing an axe or chisel-shaped drift into the apex of the A-shaped holes and finally straightening and shaping up



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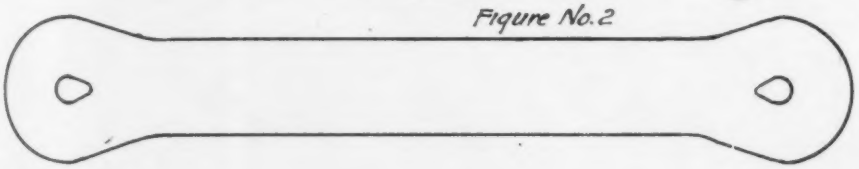

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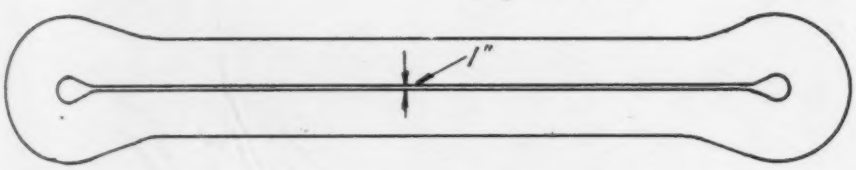

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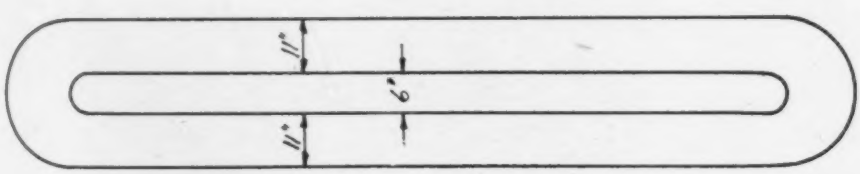

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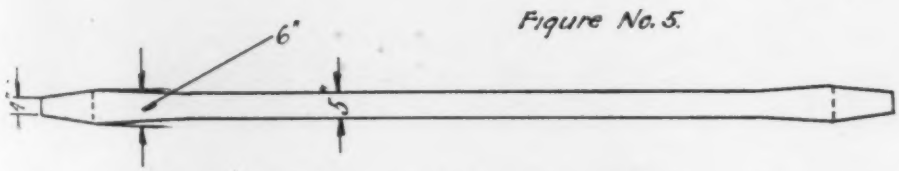

Fig. 2—Sketch Showing the Form of the 6-Ton Nickel Steel Ingots which were Used in Making these Large Ring Forgings. Figs. 3, 4 and 5—Sketches Showing the I-Bar and the Method Used in Splitting and Expanding it for Forging into a Large 8-Inch, 56-Caliber Training Circle.

under the forging press by the insertion of a heavy plate supported at the ends under the press die.

(d) One end of the now link-shaped piece was heated and curved to the exact radius of the finished ring, the ends

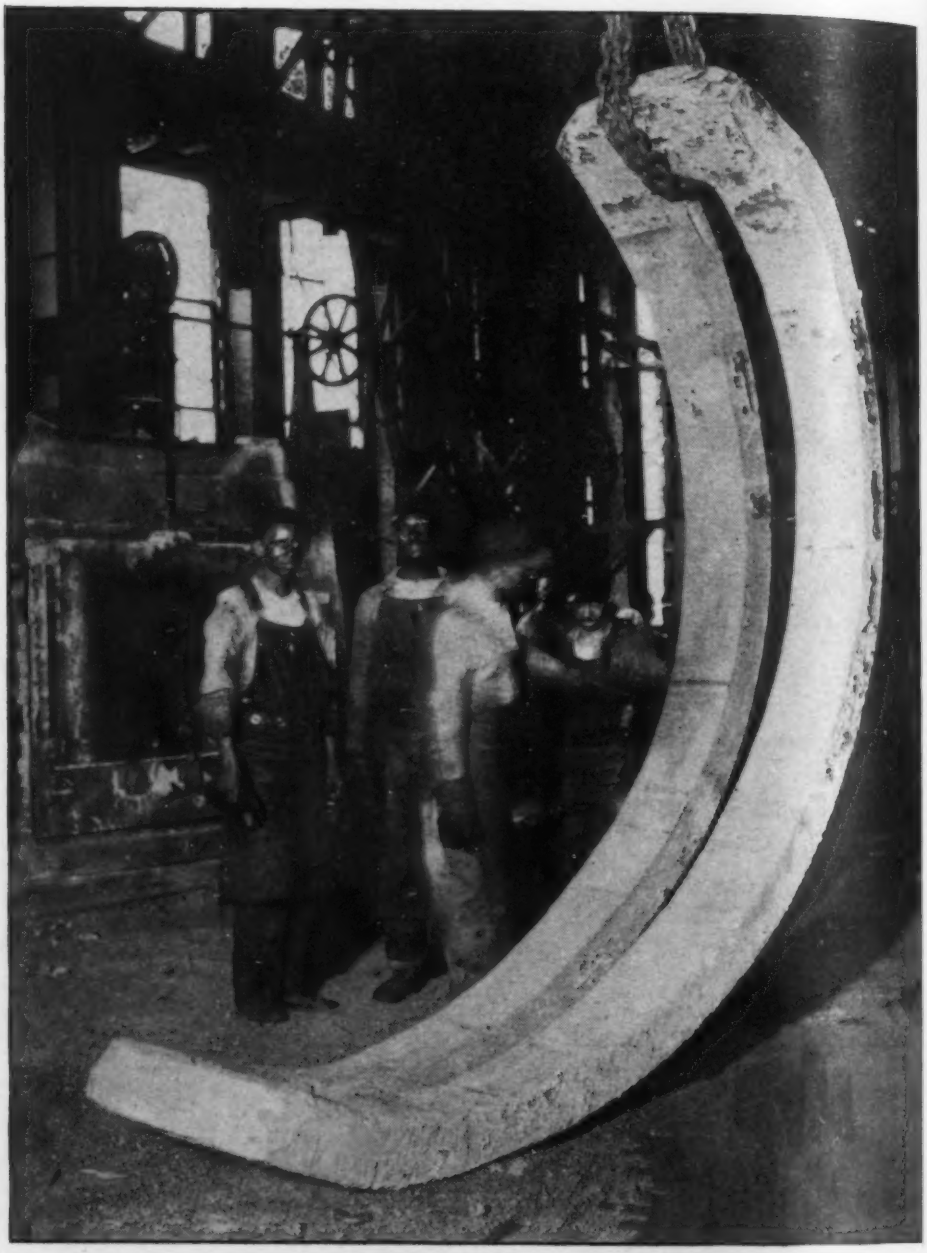

Fig. 6—Photograph Showing an Early Stage in the Manufacture of an 8-Inch, 56-Caliber Training Circle Forging. The Slotted I-Bar of Fig. 5 has been Forged to a Curve Having the Exact Radius of the Finished Ring.

were reversed and the second half heated, (the depth of the furnace not being sufficient to heat it all over) forming a semi-circle,—Fig. 6. The bending operation was performed by the usual method, i. e., by placing under the press on supporting blocks spaced some distance apart

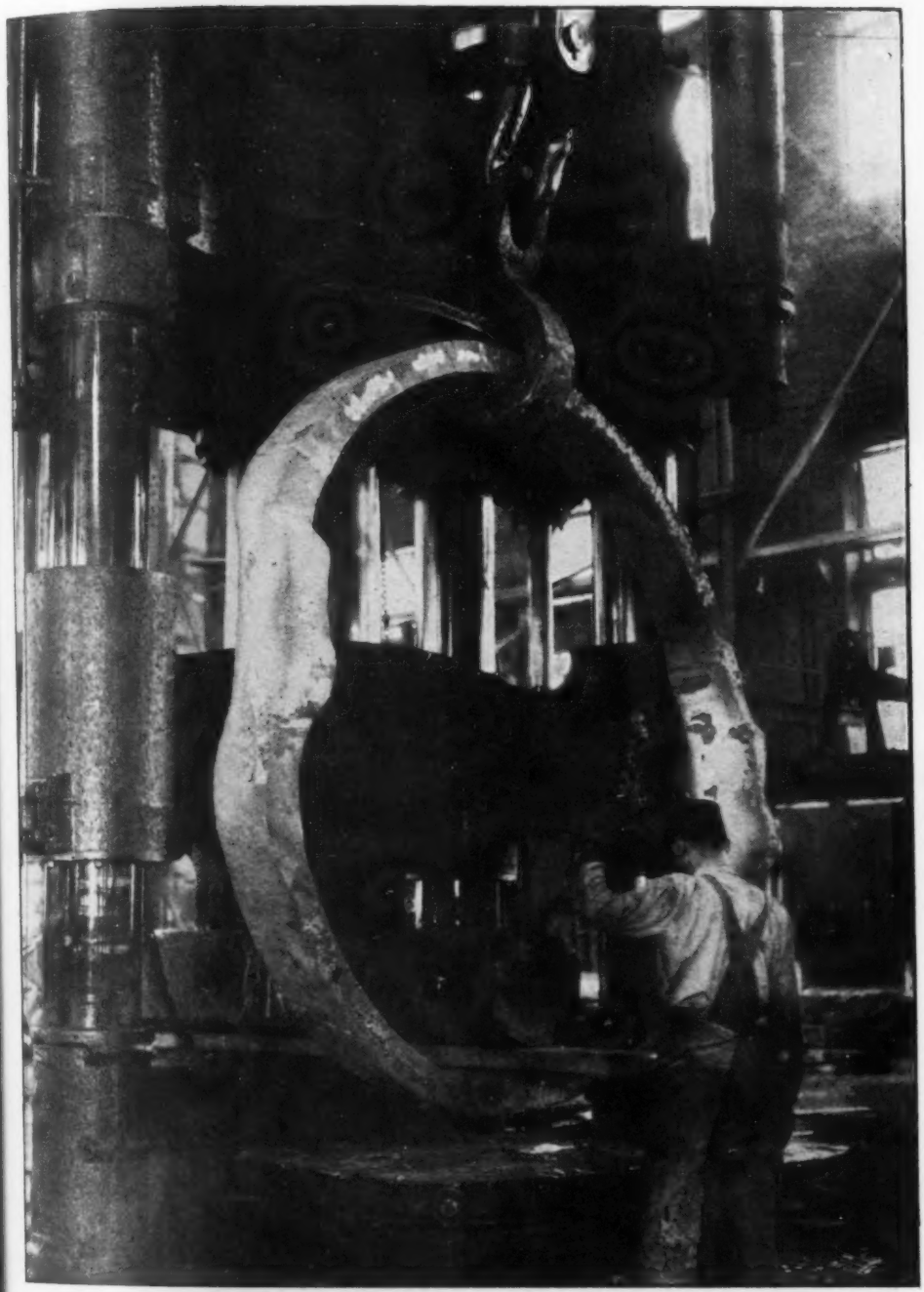

Fig. 7—Photograph Showing the Method Used in Opening the Curved I-Bar Shown in Fig. 6.

and pressed down by the use of a convex tool or roller. The ends of the piece were then placed just inside of the doors of adjacent furnaces and heated to good forging temperature, the lower mid section was inserted under a

beam held rigid by the forging press, a huge hook attached to the main hoist of a large crane hooked into the upper section and the piece pulled open, hinging at the heated

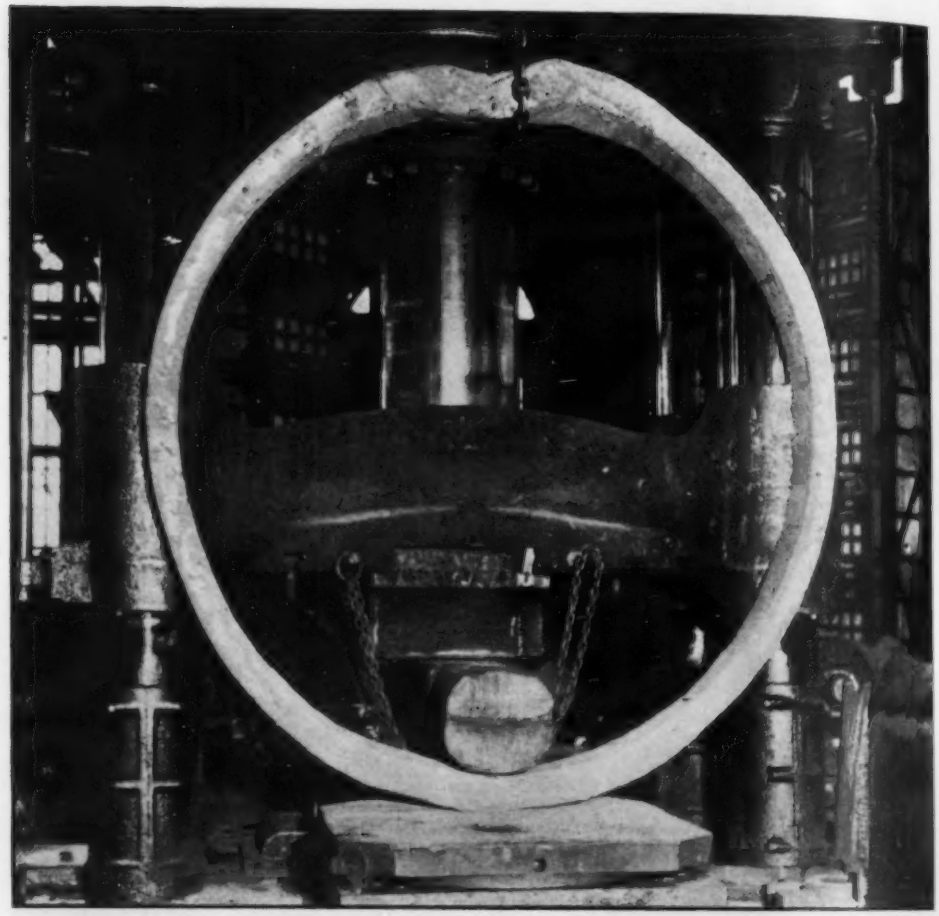

Fig. 8—Photograph Showing the Method Used in Forging the Heavy Sections of the Ring Forging when Using a Press having Insufficient Space Between the Supporting Columns. The Projecting Steel Beam Used to do the Forging can be Readily Seen.

ends in a similar manner to the opening of a steel trap, as shown in photograph, Fig. 7.

(e) At this stage it may be noted that a solid ring of the desired sectional dimensions curved to the proper radius was obtained, except for two short sections on opposite sides, these sections being heavy and irregularly shaped. The diameter of the ring across the points being held by the beam and hook was slightly short, but the mass of metal in the heavy sections had been calculated to elongate

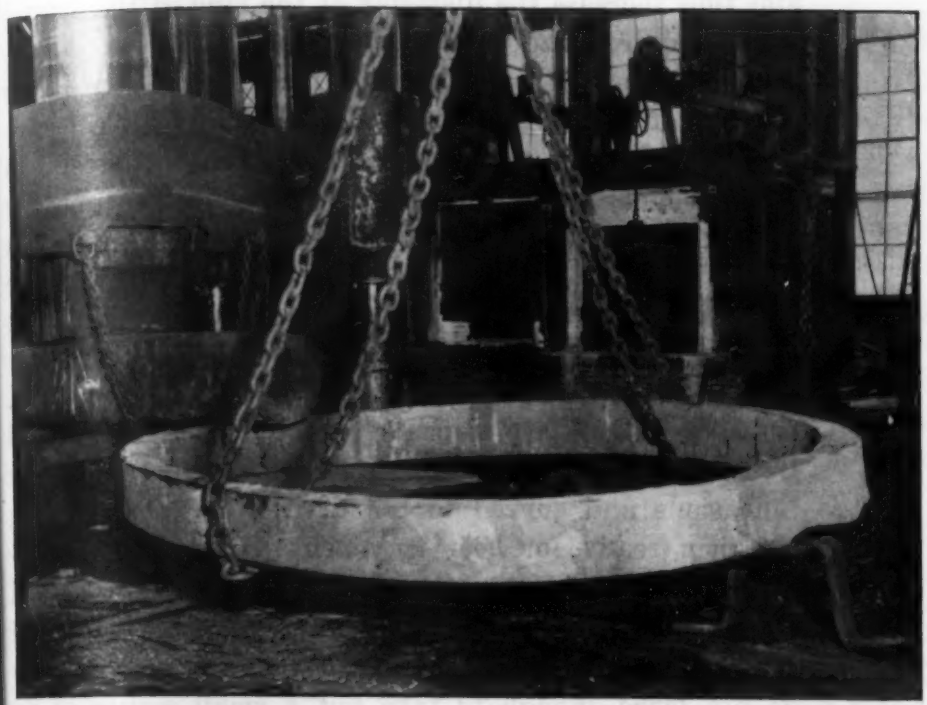

Fig. 9—Photograph Showing the Method Used in Forging Down the Lumps and Irregularities in the Large Ring Forging Made by the I-Bar Method.

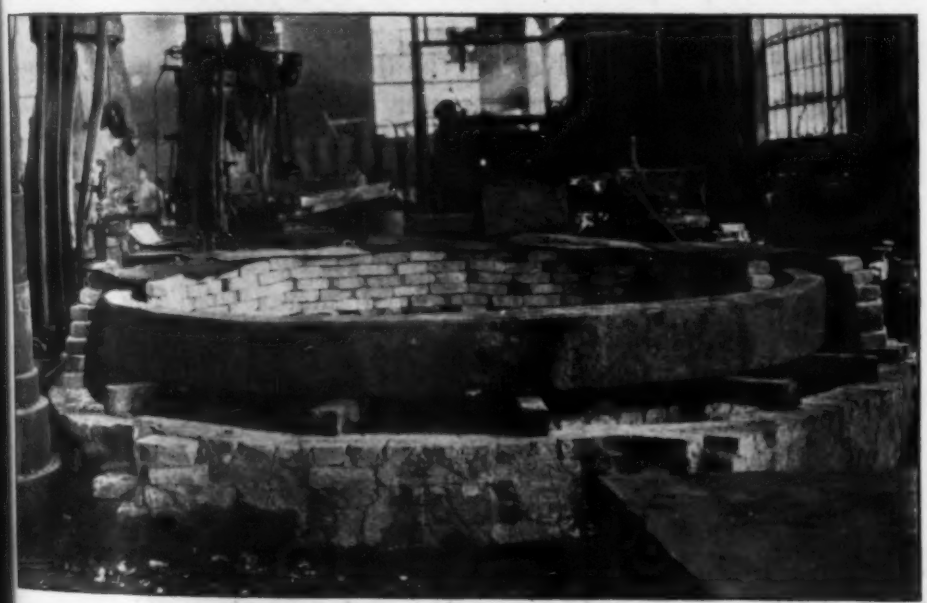

Fig. 10—Photograph Showing the Type of Heat Treating Furnace which was Devised for the Heat Treating of the Large 8-Inch, 56-Caliber Training Circle Forging. This Furnace was Equipped with Pyrometers and the Desired Rate of Cooling was Controlled by Removing Bricks from the Heating Chamber.

and thus increase the diameter of the ring at these points to the required size when shaped up.

(f) The forging was then too large to go between the columns of the forging press, though considerable forging had to be done on the heavy sections. A large steel beam with its ends projecting was swung under the upper or moving part of the press, one end resting on a pivot block to the rear, the other end projecting outward over a die block set in front of the press. The heavy section of the ring was heated by placing it just inside of a furnace door and by the use of the beam was reduced and shaped up. These operations are shown on photographs, Figs. 8 and 9. In this manner the lumps were worked down to proper dimensions and curved to the desired radius. The ring was then ready for heat treatment.

The heat treating of this ring presented difficulties second only to that of forging. This operation required uniform heating throughout the piece and as the case in forging, available furnaces were not large enough to take but a small section of the forging at one time. To build a regular heating furnace suitable for this purpose would have entailed an expenditure of something like $20,000.00, a prohibitive sum in this case, even if funds were available.

This problem was solved by the development of an improvised circular furnace of proper diameter at a labor cost of less than $500.00, the stock material used being available for use for other purposes after it had served its purpose. This furnace is shown on the photograph, Fig. 10, and consists of two fire brick circles laid with fire clay mortar 14 inches high; the outside of the inner circle is about 12 inches smaller in diameter than the inside of the outer circle, this space forming a combustion chamber for the fuel oil which is atomized by six small oil burners set at a tangent through burner blocks in the outer circle. The ring to be heated is shown in the photograph resting on steel bars spanning the combustion chamber. The heating chamber was formed by laying fire bricks without mortar around the forging, and the top covered with sheet metal which in turn is covered with a layer of sand. Pyrometer tubes were inserted at various points around the circumference by the aid of which a uniform temperature was obtained. The desired rate of cooling determined by the analysis

of the material in the forging was controlled by removing bricks from the heating chamber.

From the detailed description of operations in the foregoing it might be assumed that the manufacturing cost of these forgings was unusually high. As a matter of fact this was not so, as the actual cost compares very favorably with that of ordinary forgings of this class, being slightly less than $0.23 per pound including material, indirect heat treatment and testing costs. At the present time arrangements are in progress for the manufacture of rings 20 feet in diameter and of correspondingly larger cross-section. It is anticipated that the unit cost will be appreciably lower on these larger masses in spite of the increase in diameter.

Educational Section

These Articles Have Been Selected Primarily For Their Educational And Informational Character As Distinguished From Reports Of Investigations And Research

FACTS AND PRINCIPLES CONCERNING STEEL AND HEAT TREATMENT—PART III[1]

By H. B. Knowlton

Abstract

True annealing consists in heating the steel to just above the critical point for a long enough time to completely dissolve all but the excess cementite, followed by slow cooling. The slower the cooling through the temperatures just below the critical point the softer the steel will become. The structure is an important factor in the machinability of steel. The slower the cooling the greater will be the tendency to produce the spheroidized condition. The softest and most completely spheroidized steel may not machine the best. A mixture of laminated pearlite and spheroidized cementite is preferred.

When steel has a cementite network structure due to overheating it should be normalized by heating to above the Acm point, followed by as rapid cooling as possible. It should be further annealed after this treatment. The presence of the network structure produces poor machining and brittleness after hardening.

The loneal consists in heating to just below the critical point, followed by any rate of cooling. This treatment will soften the steel and relieve strains to some extent, but not as thoroughly as full annealing. It will not break up the network structure.

The microscope is a useful instrument in testing the efficiency of annealing. In many shops this type of inspection is not available. In such cases it is best to depend upon accurate control of the annealing process rather than an inspection.

[1]The first installment of this series of articles appeared in the March, 1925, issue of Transactions, and the second installment appeared in the June, 1925, issue.

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Annealing

ANNEALING is one of the most important of all the heat treating processes and should be performed most carefully. Good annealing requires accurate control of the time and temperature of heating and the rate of cooling. Unfortunately annealing is not always given the careful study that it deserves.

The term "annealing" is rather loosely used to mean any one of a number of treatments which attempt to relieve strains and soften steel. These treatments may be divided into two general classes. The first class, which some writers (Camp and Francis[1] for example) call "true annealing" or "full annealing," involves heating the steel to above the critical point, followed by slow cooling. The other class of treatments which are frequently called annealing, consist in heating the steel to below the critical point, followed by any rate of cooling. The A. S. S. T. has proposed the term "loneal" to apply to these treatments. It is well to distinguish between these two classes of treatments, because the results produced are quite different, although both treatments do soften the steel and relieve strains more or less. In this article they will be discussed separately.

Objectives of Annealing and Lonealing

Both the true anneal and the loneal attempt to accomplish one or more of the following objectives:—

1. To relieve strains
2. To soften the steel
3. To produce a fine grain size and the desired combination of strength and toughness
4. To produce the best structure for machining
5. To put the steel in the best condition for hardening.

At first glance it may seem that these objectives overlap, but there are really differences in the meanings of the different objectives, which may mean the use of different treatments. For example, the production of the maximum softeness is not usually accompanied by the production of the maximum machinability.

The methods for accomplishing these objectives will be de-

[1] Making, Shaping and Treating Steel.

scribed briefly at first before going into a thorough discussion of the processes.

Relieving Strains

Any rapid or non-uniform heating or cooling may set up strains in steel. Also mechanical working, such as forging, stamping, bending, twisting, etc., whether performed hot or cold, may leave the steel in a strained condition. Even machining operation may be the cause of strains. For this reason any steel which has been cast or forged should be annealed before being hardened or before being put into service in the annealed condition. Similarly, hardened steel should always be annealed before being rehardened.

As was stated in the discussion of tempering, it is difficult to give an exact temperature for relieving strains. Heating to 300-400 degrees Fahr. seems to do a great deal toward relieving strains, but heating to higher temperatures probably relieves the strains more thoroughly. Heating to just above the critical point (about 1400 degrees Fahr. for plain carbon tool steel) should relieve strains quite thoroughly. Higher temperatures should also relieve strains but are not as good for other reasons. In any case both the heating and the cooling should be slow to avoid setting up further strains.

Softening

It has already been stated in the discussion of hardening and tempering that reheating hardened steel to temperatures between 400 and 1300 degrees Fahr. will reduce the hardness of the steel. The higher the temperature (up to the critical point), the greater will be the reduction of the hardness. When the steel is heated to temperatures below the critical point, the final hardness or softness of the steel depends more upon the temperature of the heating than upon the speed of cooling. Thus a steel heated to just below the critical point and quenched in water will be quite soft.

It was also stated that if the steel is heated to above the critical point and allowed to cool slowly, it would come out soft. In this case the softness of the product depends upon the speed of cooling, not upon the temperature of heating. The faster the cooling from above the critical point, the greater will be the

hardness. A steel which is heated considerably above the critical point and cooled very slowly will become soft. This fact has led some to believe that the annealing temperature is not important. This is far from the truth. High temperatures produce a large grain size and a structure which is not the best for either machining, or for hardening.

Refining the Grain and Toughening

The finest grain size can only be produced by heating the steel to a temperature just above the critical point. It is a well known fact that the toughness of a steel depends upon the size of the grain and the structure. Other things being equal, the finer the grain the greater will be the toughness. That is, if two pieces of the same kind of steel both show the same reading on a hardness test, but one of them is coarse grained while the other has a fine grain, the piece with the fine grain will show the better combination of strength and toughness. For this reason the annealing temperature should be accurately controlled.

It is true, however, that when steel has been badly overheated that heating to just above the critical point may not be sufficient to refine the grain and produce the proper structure. In this case two or more treatments may be necessary. This will be discussed more fully under normalizing.

Producing the Best Structure

The structure of tool steel and the methods of annealing to produce the best structure for machining and for hardening will be discussed later.

Purchase of Annealed Steel

It is not always necessary or advisable for the user of steel to perform the annealing operation. Tool steel, and in fact most kinds of steel, may be purchased in the annealed condition. It is often true that steel so purchased is in the best annealed condition and will not be improved by another annealing treatment. It sometimes happens that reannealing in the user's plant leaves the steel in a worse condition. It has already been brought out that good annealing requires an accurate control of temperature,

and unless the user of steel is able to do high grade annealing it may be better to use the steel as received from the mill. An inspection of steel purchased as annealed may be worth while, providing the purchaser is equipped to make a thorough inspection. This means more than testing for hardness. Microscopic examination of the structure is probably the best test of annealing, but, unfortunately, not all users can make this test.

Of course, if the user performs any forging operations on the steel or if he wishes to machine or reharden steel which has been hardened, it is necessary to anneal. Also it may be necessary to anneal to relieve machining strains in some cases.

The Annealing Process

True annealing consists in heating the steel to above the critical point for a long enough time to produce the solid solution, followed by slow cooling. The annealing of an 0.85 per cent carbon steel will be described first, as it presents the simplest condition. Such a steel has only one critical point. As was stated in the discussion of hardening, when such a steel cools slowly from above the critical point its structure changes from austenite to martensite, to troostite, to sorbite and, finally, to pearlite, either laminated or globular form. This is the normal structure of soft annealed tool steel. Fast cooling will prevent the complete change to pearlite from taking place and will leave the steel with one of the above intermediate structures. All of these structures are harder than pearlite. Consequently, in order to produce full annealing, it is necessary that the steel cool slowly enough to allow all of the changes to take place. With these points in mind we may proceed to a more detailed discussion of the annealing process.

Heating for Annealing

If the steel has not been previously overheated it should be heated only slightly above the critical point. In the case of an 0.85 per cent carbon steel this would mean a temperature of about 1400-1450 degrees Fahr. Heating to higher temperatures would produce a coarse grain which would mean loss of toughness. Heating below the critical point does not produce the solid

solution and, consequently, does not refine the grain at all. This treatment will be discussed under the "loneal." The curing of over-heated steel will be discussed later.

The heating should be as slow and uniform as practicable. One of the objectives of annealing is the relieving of strains. Fast or non-uniform heating will produce more strains, thereby defeating one of the objectives of annealing. Large pieces should be heated more carefully than small ones, as the larger the piece the greater is the danger of non-uniform heating.

It is well to protect the steel from scaling during the annealing process. Scaling is caused by the action of air (oxygen) on the hot steel. Any plan which will keep the air away from the steel will prevent scaling. One plan for accomplishing this is to pack the steel in pipes or boxes with charcoal, coke, worn out carburizing material or some other carbonaceous material. The boxes or pipes should be covered with lids or sealed with fire clay. What little air is left in the pipes or boxes is used up in burning the charcoal or carbonaceous material. It does not have a chance to scale the steel. This method is more costly than heating in the open furnace, as there is the additional labor cost of packing, fewer pieces can be placed in a furnace at a time, and it requires more time to heat through the pipes or boxes. Heating steel in melted lead or melted salt will also keep the air away. This method is faster but is open to other objections, as the steel must be removed from the furnace for cooling. When the heating is done in the open furnace, the scaling may be kept at a minimum by covering the hearth of the furnace with charcoal or some carbonaceous material. The burning of the charcoal will use up whatever air there is in the oven of the furnace. When gas- or oil-fired furnaces are used it is possible by feeding a slight excess of the fuel to use up all of the air in the oven in burning the fuel. When a furnace is flaming slightly at the vents this condition exists. Whenever steel is annealed in an open furnace, the door should be kept closed to prevent a rush of air through the doorway.

It has already been mentioned that it is necessary to hold the steel at a temperature above the critical point long enough to produce a solid solution, austenite. The coarser the structure of the steel to begin with, the longer it is necessary to allow it to soak at the annealing temperature, in order to form the

solution and wipe out the previous structure. If the steel has a reasonably fine structure to begin with, it may be sufficient to keep it at the annealing temperature for fifteen minutes after it is thoroughly heated through at that temperature.

It is difficult to prepare a schedule for the proper heating periods of different size tools for annealing, which will hold under all conditions. A great deal depends upon the furnace in which the tools are heated. If a small tool is placed in a large hot furnace it will rapidly become heated through. On the other hand, if the same tool is placed in a comparatively small furnace it will take much longer to heat it through at the same temperature. The rate at which the tool heats depends not only upon the temperature or intensity of the heat in the furnace, but also upon the quantity of heat. The pyrometer indicates only the intensity or temperature of the heat. The quantity of heat in a furnace depends upon the weight of the furnace lining, the nature of the material used in the lining, the temperature of the lining, and the quantity and temperature of the furnace gases. When a tool is immersed in a pot of melted lead it is heated much faster than it would be in an oven of the same size at the same temperature. This is because it is surrounded by a greater number of pounds of heated material. Similarly it is true that the tool will heat faster in a pot of melted lead than it will in the same size pot of melted salt at the same temperature because the lead weighs more. The quantity of heat in a certain material also depends upon its specific heat. Specific heat is the amount of heat required to raise 1 pound of the material 1 degree.

The A. S. S. T. Recommended Practice Committee recommends a heating rate of one hour for each inch of thickness of the tool, to heat it through at the annealing temperature. Thus a tool three inches thick should be heated through in three hours, while five hours would be required for a tool five inches thick. This is a good general rule when the tools are heated in furnaces of the right size, but like all general rules for heat treating, it will not apply under all conditions for the reasons already given. The only way to work out periods for heating for any particular furnace is by actual trial. For example, the length of time required to heat a certain size tool through in a particular furnace might be determined by the use of a test piece of steel of the approximate size of the tool in question. A hole could be drilled

into the center of the test piece, and a small thermocouple could be placed in the hole, and the time required to bring the center of the test piece up to the annealing temperature could thus be actually measured. By making a few tests of this kind with different sized test pieces, the hardener could determine fairly accurately the speed with which his furnace will heat tools of various sizes, providing the heating conditions are kept as uniform as possible. This may seem to be an unnecessary amount of work, but it is too frequently true that failures in the heat treating process are due to the fact that the hardener does not know the length of time required to heat different size parts to the center.

When steel is heated in pipes or boxes, it is also necessary to know the length of time required for heating the boxes through. This might be determined in a rough way by opening the boxes after different length runs and observing whether the pieces in the center of the boxes have reached the color of the furnace. It will be found that it requires considerable time to heat the boxes through after the outside appears to be the color of the furnace.

Soaking at the Annealing Temperature

As the first step in annealing is forming a solid solution (austenite) it is necessary that time be allowed for the formation of the solution after the steel is thoroughly heated through at the annealing temperature. The proper length of time for "soaking" at the annealing temperature will depend somewhat upon the fineness of the structure of the steel before annealing. Steel which has a very fine structure will not have to be soaked as long as one whose structure is coarser. The Recommended Practice Committee of the society gives a time of 30 minutes in the case of annealing after forging and 15 minutes in the case of reannealing after machining.

Cooling

It has already been stated that when a steel which is above the critical point and, consequently, austentitic, is allowed to cool slowly, it changes back to pearlite, which is the normal structure of soft annealed tool steel. This change back to soft steel does

not begin until the steel reaches the Ar point (critical point on cooling). This is a lower temperature than the critical point on heating. Thus the critical point on heating (Ac point) of an 0.85 per cent carbon steel is about 1340-1350 degrees Fahr., while the critical point on cooling is about 1270-1280 degrees Fahr. The change which begins to take place when the steel reaches the Ar point will continue as long as the steel is hot enough to allow internal changes to take place, or until the change to the fully annealed structure is complete.

It is, therefore, important that the steel be allowed to cool slowly through the temperatures just below the Ar point. It must be remembered that the cooler the steel becomes the more difficult it is for structural changes to take place. The speed of cooling after the steel is below 700 or 800 degrees Fahr. is probably less important than the speed of cooling from 1300 down to 900 degrees Fahr. The writer once observed a 36-hour annealing process where these conditions were reversed. At the end of the annealing heat the furnaces were shut off and the charge in the furnaces dropped to a black heat in a comparatively short time. The nearer the furnace temperature approached the temperature of the room the slower the cooling became. The time required to cool from 600 to 500 degrees Fahr. was much longer than the time required to cool from 1300 to 1200 degrees Fahr. This was just the reverse of the ideal condition. A better job of annealing could have been done in a shorter time by cooling the steel more slowly between 1300 and 1000 degrees Fahr. and then allowing it to cool faster from 1000 degrees Fahr. down.

Various methods may be used for producing the slow cooling necessary for full annealing. If the steel is annealed in the furnace oven without being packed in boxes or pipes, it may be well to shut off the heat gradually, thus causing the steel to cool slowly from the annealing temperature down to about 900-1000 degrees Fahr. It may even be advisable to hold the furnace steady at a temperature a little below the Ar point (critical point on cooling) for an hour or more because the changes in the structure of the steel take place more readily at this temperature than at lower temperatures. If sufficient time has been allowed during the cooling from the annealing temperature to 900 or 1000 degrees Fahr. (the first black heat) it may be possible to remove the steel from the furnace and allow it to cool in air to room tem

perature. Some prefer to allow the steel to cool in the furnace to 600-700 degrees Fahr. The obvious objection to cooling the steel in the furnace is that it ties up the furnace. However, if the furnaces are not in use at night it is possible to run the annealing heat late in the afternoon and allow the steel to cool in the furnace over night.

When the steel is packed in pipes or boxes it is better to cool them in the furnace as described above. However, even if the boxes are removed from the furnace at the annealing temperature the steel inside will cool fairly slowly. When the steel is heated in the open furnace and it is impracticable to cool in the furnace, it is necessary to devise some other means for slow cooling outside of the furnace. This may be done by burying the heated steel in lime, infusorial earth or some other poor conductor of heat.

This method is not as good as cooling in the furnace. It is obviously impossible to hold the steel for any length of time at a temperature just below the critical point. If the steel is heated in melted lead or salt this is about the only practical method of cooling.

Results

By comparing the annealing method just described with the statements concerning what is necessary to meet the first three objectives of annealing, it will be seen that this method will relieve strains, soften the steel and refine the grain. This applies to an 0.85 per cent carbon tool steel. The same principles apply with variations to all steels. The medium carbon and low carbon steels will be considered in later articles. It may be well now to consider the annealing of tool steels containing more than 0.85 per cent carbon.

Structure of Plain Carbon Tool Steel

Before going into the discussion of the annealing of the high carbon tool steels or of the production of the maximum machinability, it is necessary to give a brief discussion of the structure of the plain carbon tool steels. The steels containing from 0.70-1.50 per cent carbon are usually classed as the tool steels. However, in annealed tool steel, the carbon does not appear in the form of free carbon. In gray cast iron and in malleable cast iron it

does appear in the form of free carbon. When such cast irons are examined under the microscope, the carbon may be seen in the form of small black spots. This is not the case with tool steel in the normal condition. The carbon is present as "iron carbide," which is a chemical compound of iron and carbon.

Iron carbide (called "cementite" by the metallographists, and "combined carbon" by the casting men) is different in its properties from either iron or carbon. It is as hard and as brittle as glass. It is similar to other compounds in that its properties are different from those of the elements of which it is composed. For example, water is a chemical compound of hydrogen, a gas which burns easily, and oxygen, the gas in air which helps all fuels to burn. Water is obviously quite different from either of these gases. On the other hand, a mixture has properties which are similar to those of its components. For example, if sand and salt are mixed together, the mixture formed has all of the properties of both the sand and the salt. Such a mixture would taste salty and feel gritty. It may be said, then, that a mixture is composed of two or more substances, the particles of which are close together, but it has the properties of all of the substances of which is is composed. A chemical compound is composed of two or more substances which are united to form a material which is entirely different in its properties from any of the substances of which it is composed.

Annealed tool steel may be considered as a mixture of iron and iron carbide (combined carbon or cementite). Both the iron and the iron carbide are broken up into fine particles and are thoroughly mixed together, but they may be actually seen and distinguished from each other under the microscope. It is true that the plain carbon tool steels also contain small amounts of manganese, sulphur, phosphorus and other elements, but for the present discussion they will be considered simply as alloys of iron and carbon. It may be expected that the properties of annealed tool steel will be that of both the iron and the iron carbide. This is the case. Pure carbonless iron is comparatively soft, tough, and machinable. Iron carbide is hard and brittle and cannot be machined at all. When a tool strikes a particle of iron carbide in the steel, either the iron carbide (cementite) is broken, or else the steel splits along the side of the cementite particle.

From this it should be easy to see that the machinability of annealed tool steel will depend, in part, upon the size and the arrangement of the hard cementite particles. This is a point which is often overlooked by many users of tool steel. In some plants the cost of machining tool steel is not carefully studied. On the other hand, in some of the large tool manufacturing plants, the cost of machining of tool steel is recognized as a vital factor, and a study has been made of what causes good and poor machinability. An article[2] on the effect of structure on the machining of tool steel was published in TRANSACTIONS, September, 1922. This covers the subject in a more thorough way than can be attempted in the present article. It was brought out quite conclusively in that article that the ease or difficulty of machining does not depend entirely upon the softness or hardness of the steel. It is not true that the softer the steel the easier it will be to machine. Much depends upon the structure. Other metallurgists have found the same to be the case.

It is also true that the toughness of tool steel after hardening depends, in part, upon the structure of the steel before hardening.

STRUCTURE OF ANNEALED 0.85 PER CENT CARBON STEEL

Under some conditions annealed 0.85 per cent carbon steel may be made up of alternate plates of iron and cementite. This condition is called "laminated pearlite." This name has been chosen because a polished and etched specimen has the appearance of "mother-of-pearl" in a shell. This structure is shown in Figs. 1 and 4. The white lines in the photomicrographs are cementite (iron carbide) and the dark lines are carbonless iron. (The colors were produced by etching with dilute acid.) Fig. 1 was taken at a magnification of 500 diameters. The real size of the plates of iron and cementite in the steel may be figured by counting the number of dark and light lines in the photograph and dividing by 500. It will thus be found that there are in the steel about 40,000 of these plates to the inch. This is a comparatively coarse structure for this kind of steel and is not the ideal structure for machining.

As stated before, this is not the ideal structure for machin-

[2] "The Effect of Structure Upon the Machining of Tool Steel," by J. V. Emmons, TRANSACTIONS of A. S. S. T., Vol. 2, September, 1922, page 1100.

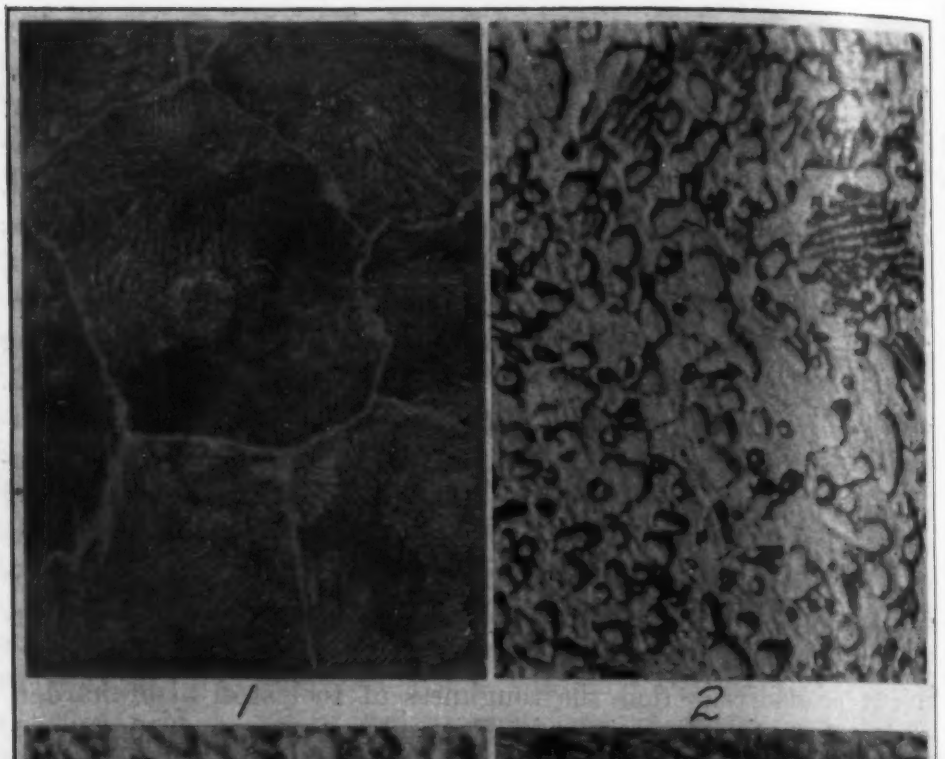


Fig. 1—Laminated Pearlite in a Carbon Steel Having a Carbon Content of 1.20 Per Cent. Specimen Annealed at 1750 Degrees Fahr. Magnification 500x. Note Network Surrounding the Grain. Fig. 2—The Same Bar of Steel "As Received" from the Mill in the Annealed Condition. Magnification 2000x. Structure Mostly Spheroidized Cementite, and Ferrite (Iron). Fig. 3—The Same Bar: Annealed at 1750 Degrees Fahr., Reannealed at 1400 Degrees Fahr. Network Structure Not Entirely Broken Up. Magnification 2000x. Fig. 4—The Same Bar: Annealed at 1750 Degrees Fahr. Normalized at 1600 Degrees Fahr., Cooled in Air. Magnification 2000x.

ing. The tendency is for the steel to split along cementite lines. This does not produce the finest finish possible. Fortunately, annealed tool steel does not always show this structure. Under some conditions the cementite may take the shape of small balls. This structure will be more fully discussed a little later in this article.

Structure of High Carbon Tool Steel

It is a peculiar fact that a structure of 100 per cent pearlite can only be produced in steels which contain about 0.85 per cent carbon. In steels which contain more than 0.90 per cent carbon there appears besides the pearlite (fine plates of iron and cementite) larger particles of cementite. These are sometimes called "excess cementite." The term excess comes from the fact that there is more cementite in the steel than can be held in the pearlite. From the standpoint of useful value, a large amount of cementite may be far from excessive. Cementite which does not form a part of the pearlite is also called "free" or "massive" cementite. It is free in that it does not form a part of the pearlite. It is called massive because it forms in larger particles when free than when forming a part of the pearlite.

The free or massive cementite in tool steel containing more than 0.85 per cent carbon sometimes forms envelopes completely surrounding each grain or crystal of pearlite. This condition is shown in Fig. 1. This photomicrograph shows the structure of a high grade 1.20 per cent carbon tool steel after annealing by heating to 1750 degrees Fahr. and cooling in the furnace. The free cementite appears in the form of a white network surrounding the pearlite grains. The photomicrograph is really a picture of a polished section cut through the grains. If it were possible to photograph the solid grains instead of a section through them, the cementite would not appear as a network but as envelopes completely surrounding each grain or crystal.

The structure shown in these photomicrographs, coarsely laminated pearlite grains surrounded by envelopes of cementite, is a bad condition. As each of the pearlite grains is completely surrounded and separated from its neighbors by a film of hard brittle cementite, the tendency is for the grains to break apart from each other. When steel with such a structure is machined it is found that the steel cracks ahead of the tool, the cracks usually

following the grain boundaries. If the cracks do go through the pearlite grains, they follow the plates or laminations, not the direction of the tool. Such machining is really a series of splitting operations. It leaves the steel with a rough finish. The envelopes of cementite are also hard on the cutting tools, causing them to wear out rapidly. If such a steel is given an ordinary hardening treatment it will be brittle after hardening because the cementite will be left in the envelope or network form.

The structure just described is produced by slow cooling from high temperatures. It may appear to some extent in steel after forging, if the finishing temperature of forging is high. It always appears in high carbon steel which is heated to a high temperature for annealing and allowed to cool slowly. This condition is sometimes called "burnt," although it is not literally burnt. The truly burnt steel has some of the carbon actually burned out of it. For this there is no cure, but steel which has been annealed at too high a temperature can be cured by proper heat treatment. This will be discussed more fully later.

A much better structure for annealed high carbon tool steel is shown in Fig. 2. This illustration shows the same bar of 1.20 per cent carbon steel mentioned before as it was received from the steel mill in the annealed condition. It will be noted that the structure is vastly different. There are no large pearlite grains made up of parallel plates of iron and cementite and there are no envelopes of free cementite. Most of the cementite appears in the form of small rounded particles. As these are somewhat ball or sphere shape they are called "spheroids." (A spheroid is a solid somewhat the shape of a sphere but not a perfect sphere.) Cementite in this condition is called "spheroidized cementite." This structure is sometimes called "granular" or "globular" pearlite. The background is carbonless iron. It will also be noted that there are a few parallel plates of cementite in the picture. This approaches the structure which Emmons considers the best average condition for all machining operations. Sometimes steel has a completely spheroidized structure with no laminated pearlite at all. Emmons does not consider this good. It is really too soft for many machining operations, although tool makers will report it as hard because it does not machine well. For this reason, some users of tool steel use the microscope as a means of examining incoming tool steel. This does not mean that

steel should be purchased on the basis of the microscopic examination alone. The chemical composition, the hardness, and the care with which the steel is manufactured are all important factors in determining good tool steel.

Effect of Heat Treatment on Free Cementite

It has already been mentioned that when an 0.85 per cent carbon steel is heated to just above the critical point, a complete solid solution, austenite, is formed. It is also true that when a higher carbon steel is heated to just above the critical point, a solid solution, austenite, is formed. It is also true that when means that all of the steel having the pearlitic structure will dissolve to form austenite at the critical point, but that the free or excess cementite will not dissolve into the austenite at that temperature. Austenite at the critical point will dissolve 0.85 per cent carbon and no more. Like most solutions, the dissolving power of austenite increases as the temperature is raised. The higher the temperature, the greater will be the amount of carbon, or, more properly, cementite, which will be dissolved by the austenite.

From this it follows that if the cementite is in the best (spheroidal) form before hardening, heating to just above the critical point for hardening will not change it. The hardened steel thus produced will have a hardened structure (martensite or troostite) plus thousands of small ball-like particles of free cementite evenly distributed through the steel. Cementite in this form increases the hardness or resistance to wear of the steel without greatly increasing the brittleness.

Also if the steel has been annealed at too high a temperature and the cementite is in the network or envelope form, hardening from just above the critical point will leave the cementite in the envelope form. Cementite in this form does not so greatly increase the hardness of the steel but does greatly increase its brittleness. This is obviously a bad condition and should be avoided.

If high carbon steel is received from the mill in the best annealed condition, the user should be careful not to produce a poorer structure by annealing at too high a temperature. On the other hand, if the steel has been overheated and has coarse

laminated pearlite, or cementite network structure, the ordinary annealing at temperatures only slightly above the critical point will not be sufficient to break up the structure.

Curing Overheated Steel

When a high carbon steel has been overheated and has the structure just described, the ordinary annealing at temperatures just above the critical point will not be sufficient for producing the proper structure. Fig. 3 shows the effect of such a treatment upon steel which has been cooled slowly from 1750 degrees Fahr. This is a microphotograph of the same bar of steel shown in Fig. 1 after reannealing at 1400 degrees Fahr. for 1½ hours. The steel was allowed to cool in the furnace to 1100 degrees Fahr. and held at that temperature for 3 hours. It will be noted that the network of cementite remains. However, the cementite in the pearlite has taken the spheroidized form rather than the plate form shown in Fig. 1. This steel was very soft. The Brinell reading was 179. In spite of this it would not be in the ideal condition for machining on account of the network of cementite. After hardening it would probably be brittle.

Normalizing

In order to fully break up the network structure of overheated steel, a rather drastic heat treatment, called "normalizing," is necessary. The first step in this heat treatment is to dissolve all of the cementite. This means heating to temperatures considerably above the critical point. The temperature at which all of the cementite will dissolve will depend upon the carbon content of the steel. These temperatures are frequently shown in diagram form.

Such a diagram is shown in Fig. 5. Each of the vertical lines represents a steel of a different carbon content. The figures at the bottom of the diagram show the carbon contents represented by these lines. Each horizontal line represents a different temperature. The figures at the left state the temperatures represented by these lines. The nearly horizontal line across the chart labeled $Ac_{3\text{-}2\text{-}1}$ shows the critical points of the different steels. The slant line labeled A_{cm} shows the temperatures at which

all of the cementite in these steels may be dissolved in the austenite.

To use this diagram in determining the treatments for any particular steel, observe the bottom of the diagram and select the vertical line corresponding to the carbon content of the steel in question. Follow this line to its intersection with the $Ac_{3\text{-}2\text{-}1}$

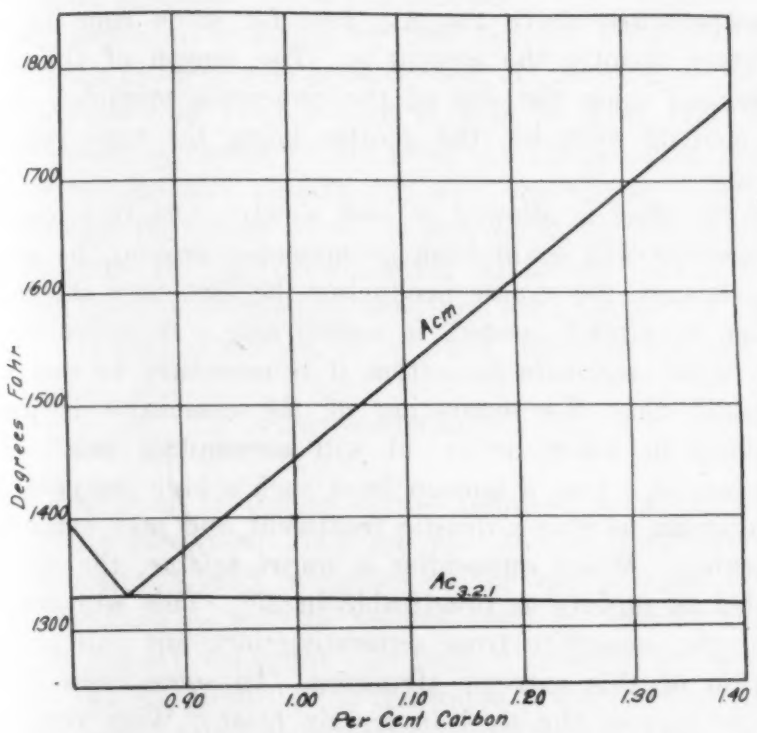


Fig. 5—Diagram Showing the Critical Points and Acm Points of High Carbon Steels.

line. At the point of intersection follow the horizontal line to the left side of the page to find the temperature of this point. This will be the critical point of the steel. Similarly to find the point at which all of the cementite will dissolve, follow the vertical carbon content line up to the intersection with the slant line A_{cm} and again observe the corresponding temperature at the left. For example, the critical point of a 1.00 per cent carbon steel is about 1340 degrees Fahr. and the point at which the cementite will dissolve is about 1450 degrees Fahr. Similarly the critical point of a 1.20 per cent carbon steel is about 1330 degrees Fahr. and temperature at which all the cementite dissolves is about 1610 degrees Fahr. As already mentioned for

ordinary hardening and annealing, steel should be heated a little above the critical point. It will be noted from this diagram that the critical point is nearly the same for all steels of over 0.85 per cent carbon. For dissolving cementite, the steel must be heated above the A_{cm} point. It will be noted that the temperature of the A_{cm} point becomes higher with the increase of the carbon content. It is, of course, necessary to hold the steel at the temperature above the A_{cm} line for some time in order to completely dissolve the cementite. The length of time required will depend upon the size of the cementite particles, the larger the cementite particles, the greater being the time required for solution.

If the steel is allowed to cool slowly from this temperature, the cementite will again form in envelopes around the grains and plates through the grains producing the structure shown in Fig. 1 which, as already stated, is undesirable. In order to prevent this type of cementite formation it is necessary to cool the steel so rapidly that the separation of the cementite is prevented. Quenching in water or in oil will accomplish this. However, in the case of a tool, a quench from such a high temperature may be dangerous, as it is a drastic treatment and may cause warping or cracking. When quenching is impracticable, the steel should be cooled as rapidly as practicable in air. This will not entirely prevent the cementite from separating out, but will prevent the formation of this extreme structure. In some cases it may be advisable to cool the steel in an air blast. With regard to air cooling, it must be remembered that small pieces will cool much more rapidly than large ones. A very small piece cooled in air may have the same structure as the center of a large piece cooled in oil. On the other hand, there is greater danger of cracking when the large piece is quenched. The selection of the method of cooling must, in the end, be left to the judgment of the heat treater. In general the steel should be cooled as rapidly as possible without producing danger of warping or cracking.

Fig. 4 shows the effect of a normalizing treatment consisting of heating to 1600 degrees Fahr., followed by air cooling upon the structure shown in Fig. 1. It will be noted that the cementite network it not entirely wiped out. This is either because the temperature was not quite high enough or because the time at heat was not long enough. The rest of the structure consists of

sorbite, plus fine laminated pearlite and spheroidized cementite.

While the normalizing treatment eliminates the network structure it produces a coarse grain size. This is due to the high temperature required for dissolving the cementite. For example, the normalizing temperature for a 1.20 per cent carbon steel is over 1600 degrees Fahr., while the temperature which produces the finest grain is about 1375-1400 degrees Fahr. Consequently, normalizing means overheating by 200 degrees Fahr., so far as producing a fine grained steel is concerned. If the steel is quenched from the normalizing temperature it will be hard and brittle. Even if the steel is cooled in air from the normalizing temperature it will not be soft enough for easy machining. Obviously the normalizing treatment alone is not sufficient for producing the best structure in high carbon steel. It merely serves to wipe out the structure of overheated steel and to prepare for further treatments. It should always be followed by an annealing treatment.

Spheroidizing

The normalizing treatment is best followed by a "spheroidizing" annealing treatment. The purpose of this treatment is to put the cementite (partly, at least) in the spheroidized form already described. This may be accomplished by heating the steel to just above the critical point (Ac point), followed by slow cooling through the Ar point. This treatment always causes the free or excess cementite to take the spheroidized form. There is never any danger of forming network or envelopes of cementite. If the cooling is only moderately slow considerable laminated pearlite (parallel plate structure) may be formed. If the cooling is extremely slow from the Ac point through the Ar point all of the cementite will take the spheroidized form. Emmons has shown that neither of the extreme conditions is the best from the machining standpoint. He recommends a speed of cooling which will produce a structure containing about 25 per cent pearlite and the balance spheroidized cementite, and carbonless iron. Fig. 2 comes the nearest to showing this structure. It will be noted that in this illustration there is about 10 per cent of the parallel plate or pearlitic structure. Spheroidized cementite may also be produced by heating to just below the critical point. This will be discussed presently.

Lonealing

The loneal consists in heating to some temperature below the critical point, followed by any rate of cooling. Tool steel is usually heated just a little below the critical point, in other words, from 1100-1300 degrees Fahr. This treatment is in effect the same as a high drawing or tempering treatment. The only objection to calling this treatment tempering is that tempering is usually understood to be a treatment following hardening, while the loneal may be applied to either hard or soft steel. The principal advantage of this treatment over the true annealing is that a slow cooling speed is not required. The results produced by the loneal depend somewhat upon the condition of the steel before treating. They will, therefore, be discussed with reference to effects upon original structures.

Steel in the Best Hardened Condition

If the steel is in the best hardened condition its structure will consist of fine martensite or troostite, plus free cementite in the spheroidized condition. A loneal given to steel of this structure will greatly reduce the hardness and increase the toughness and will, to a large extent, relieve strains. It will not, however, produce as great softness as full annealing. The final structure will be sorbite, plus free spheroidized cementite. Sorbite is somewhat harder than pearlite and does not machine as easily. As it is a fine grained structure, consequently there is no tendency to tear or split. It is, therefore, possible to produce a fine finish on steel of this structure. There is, however, considerable wear on the tools in machining this type of structure.

This treatment finds an application when rapid "annealing" is desired. The steel is first hardened at the usual temperature and then given the loneal at 1200 degrees Fahr. or thereabouts. If the steel has not been previously overheated, the hardening treatment will refine the grain, dissolve any existing laminated pearlite and produce a structure consisting of fine martensite or troostite, plus cementite. The effect of the loneal has already been described. This treatment should be called hardening and tempering, rather than annealing. It will serve to wipe out a structure of coarsely laminated pearlite, but it will not destroy the network structure, if such exists.

Steel Containing Cementite Network

If the steel contains free cementite in the network form, as shown in Fig. 1, a loneal will not wipe out the structure. Fig. 6 shows the structure of the bar shown in Fig. 1 after reheating to

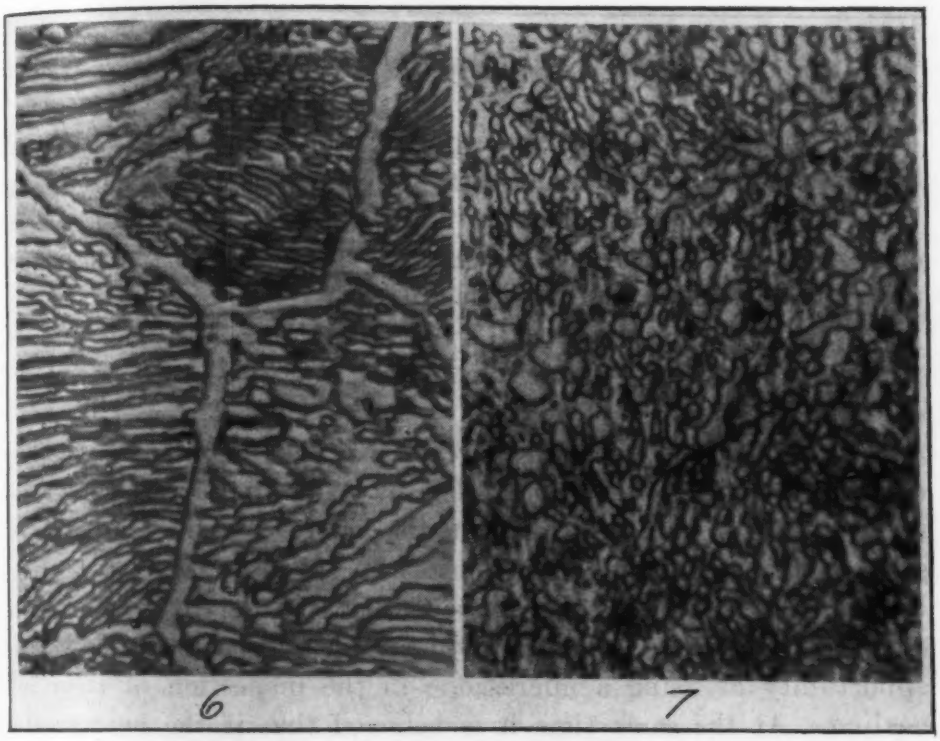


Fig. 6—Same Bar as in Previous Micrographs. Annealed at 1750 Degrees Fahr., Followed by Loneal at 1200 Degrees Fahr. Structure is Not Refined by the Treatment. Magnification 2000x. Fig. 7—Same Bar. Annealed at 1750 Degrees Fahr., Reheated to 1650 Degrees Fahr., Quenched in Oil, Reheated to 1200 Degrees Fahr. Magnification 2000x. Note Spheroidized Structure.

1200 degrees Fahr. for two hours. It will be noted that both the cementite network and the pearlite plates remain. Evidently this treatment is not sufficient for refining the coarse structure produced by slow cooling from 1750 degrees Fahr.

Steel Normalized by Oil Quenching from Above the Acm Line

Fig. 7 shows another section of the bar which was annealed at 1750 degrees Fahr., after being reheated to 1650 degrees Fahr., quenched in oil and reheated again to 1200 degrees Fahr. for two hours. It will be noted that the cementite is almost entirely

in the spheroidal form. Both the network and the pearlite plates have disappeared. This treatment seems to be effective in refining the structure but does not quite produce the structure recommended by Emmons. If the last treatment had been an anneal, with the proper cooling speed, instead of a loneal, the results would probably have been better.

Steel with a Laminated Pearlite Structure

If the steel has the structure of laminated pearlite it may be possible to produce more of the globular or spheroidized form by a long loneal. The time required probably depends upon the coarseness of the original structure. The coarser the structure the greater will be the time required.

Conclusions

It may seem from the foregoing discussion that annealing can only be successfuly controlled by examination of the microscopic structure. It is true that the microscope is a useful instrument for the study of the results produced by annealing. In too many places the hardness test is considered entirely sufficient. It is realized that many heat treaters will not have the opportunity of using a microscope in the inspection of their annealing. At the same time it is believed that if the heat treater knows the structures which are produced by the different treatments and understands the effect of the different structures on the machinability and the physical properties of the steel, that he will be able to do much better annealing. He will have to depend upon carrying out the process accurately in a way which he knows will produce the best results, and not depend upon an inspection to determine whether the steel is properly annealed. After all, the best test is actual performance in service, but this, unfortunately, is a slow and often expensive test.

It has not been attempted in this article to give all of the possible treatments which may be used for softening steel and removing strains. It has been attempted, rather, to explain the general principles, so that the heat treater may better work out his own problems.

Comment and Discussion

Papers and Articles Presented Before the Society and Published in Transactions Are Open to Comment and Criticism in This Column—Members Submitting Discussions Are Requested to give Their Names and Addresses

Boston, Sept. 21, 1925

Dear Mr. Eisenman,

Concerning our conversation at the Convention last week about the Golf Tournament held here in Boston during the week of the Boston Convention last year, I am enclosing a copy of the score as submitted to me by I. L. Bambrick.

Since the Entertainment Committee of Boston had not figured on a Golf Tournament, we were unable to allow very much money for prizes. After much bargain hunting, the committee succeeded in purchasing six steel shafted wooden sticks.

Three sticks were distributed to the three lowest gross scores. Mr. Bambrick won one of the prizes on gross score, but did not take it, delivering these prizes to J. R. Lenahan 89, Mastrifort 92, Morrissey 93.

Of the net scores there were five with a 71, A. L. Sullivan, Gordon Litchfield, E. R. Estabrook, K. A. De Lanen and T. A. Wry. Having only three prizes lots were drawn for them, Mr. Sullivan, Mr. Litchfield and Mr. Wry winning the draw.

I sincerely hope you will take steps to clear the Boston Convention Committee of any misunderstanding arising in this instance.

Yours very truly,

Signed: G. C. DAVIS, *Sec'y.*

SCORES OF PLAYERS AT BOSTON CONVENTION

	Gross Score	Handicap	Net Score
I. L. Bambrick	87	14	73
J. Ray Lenahan	(89)	17	72
O. Mastrifort	(92)	20	72
J. W. Morrissey	(93)	20	73
A. L. Sullivan	94	23	(71)
Zay Jeffries	95	10	85
Gordon Litchfield	97	26	(71)
E. R. Estabrook	98	27	71
K. A. De Lanen	100	29	71
Tom A. Wry	101	30	(71)
A. W. Tall	106	30	76
H. R. Wade	112	28	84
N. B. Hoffmann	122	24	98
A. F. Braid	122	30	92
H. S. Hunter	129	30	99
D. R. Smith	129	30	99
W. S. Bidle	129	30	99

Reviews of Recent Patents

By
NELSON LITTELL, Patent Attorney
110 E. 42nd St., New York City
Member of A. S. S. T.

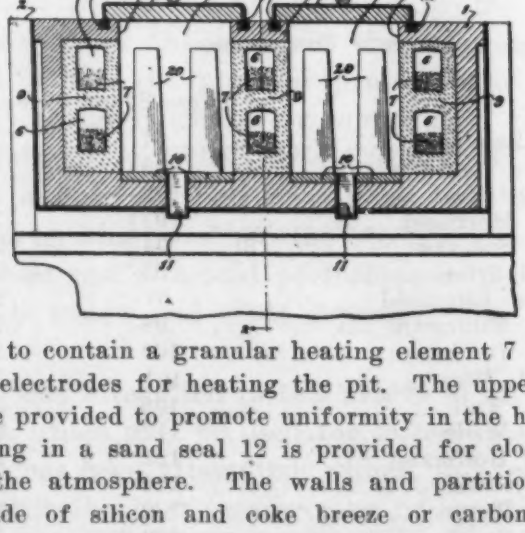
Through the courtesy of Nelson Littell, we have secured an additional library service for members of the A. S. S. T. This service comprises the selecting and supplying of copies of current patents, on specified subjects, as they are issued by the Patent Office.

Mr. Littell will review the Official Gazette each week, selecting those patents on subjects desired by individual subscribers, and order separate copies mailed directly to them from the U. S. Patent Office. Subscribers may specify the field of patents in which they would be interested in receiving current information on, or they may supply a list of their products and manufacturing processes whereby Mr. Nelson could judge as to what patents would be of interest to them.

The cost for this service is $10.00 per year, plus 10 cents per copy for each copy of a patent furnished.

1,546,533, Soaking Pit, Thaddeus F. Baily, of Alliance, Ohio.

This patent describes a soaking pit for uniformly heating ingots in a non-oxidizing atmosphere. The pit comprises a rectangular opening 1 separated by partition walls 4 into a plurality of holes 3. The partitions and side walls of the pit are preferably hollow and provided with longitudinal pas-



sages 6 adapted to contain a granular heating element 7 connected at each end to suitable electrodes for heating the pit. The upper and lower heating elements are provided to promote uniformity in the heat of the pit and a door 14, resting in a sand seal 12 is provided for closing each opening and excluding the atmosphere. The walls and partitions are preferably formed of carbide of silicon and coke breeze or carbon is placed in the bottom of the openings to provide a non-oxidizing atmosphere.

1,547,928, **Process of Making Alloy Steel, Alan Kissock, of New York, N. Y., assignor to Carl M. Loeb, of New York City.**

This patent describes the process of making molybdenum steel wherein the molybdenum is added as an oxide directly to the steel furnace during the steel making process and the oxide is reduced by the constituents of the bath, no other reducing agent being added.

1,549,022, **Method of Treating the Surfaces of Cold-worked Iron Chromium Alloys, Otho M. Otte, of Tarentum, Pennsylvania, assignor to Valley Holding Corporation, of Brackenridge, Pennsylvania, a Corporation of Pennsylvania.**

This patent describes a method of increasing the resistance to corrosion of cold-worked chromium alloys, which comprises the treating of the distorted surface of the annealed chromium alloy, which does not resist corrosion to the desired degree, by immersing them in hot nitric acid. A few minutes treatment materially increases the resistance of the article to corrosion.

1,549,312, **Process of Desulphurizing Iron and Steel and a Composition of Matter for Use in Said Process, Daniel D. Jackson, of Brooklyn, New York, Joseph D. Sears, of Bloomfield, and Frederick Conlin, of Westfield, New Jersey, assignors to said Jackson, said Sears, and John T. Pratt, of New York City, as Joint Trustees.**

The patent describes a method of eliminating sulphur from iron, steel, ferro-alloys, etc. by treating the molten metal containing the sulphur with alkali metal compounds, such as sodium hyrdoxide which is compounded with an alkali metal carbonate, such as sodium carbonate, the alkali metal carbonate acting to reduce the volatilization of the hydroxid. Sodium silicate may be used as a binder for the treating materials.

1,549,646, **Method of Manufacturing Alloys from Iron, Albert Wittig, of Berlin, Germany.**

This patent describes the process of removing phosphorus and arsenic from the alloys, such as ferromolybdenum, ferrovanadium, ferrowolfranium, ferrochromium and the like, which comprises treating solutions of these metals with zirconium compounds or salts, which precipitate any phosphorus or arsenic present in the solutions.

1,549,865, **Method of Treating Iron Ore, Julius Howells Gillis, of Sudbury, Ontario, Canada, assignor of one-half to Thomas Robinson, of New York City.**

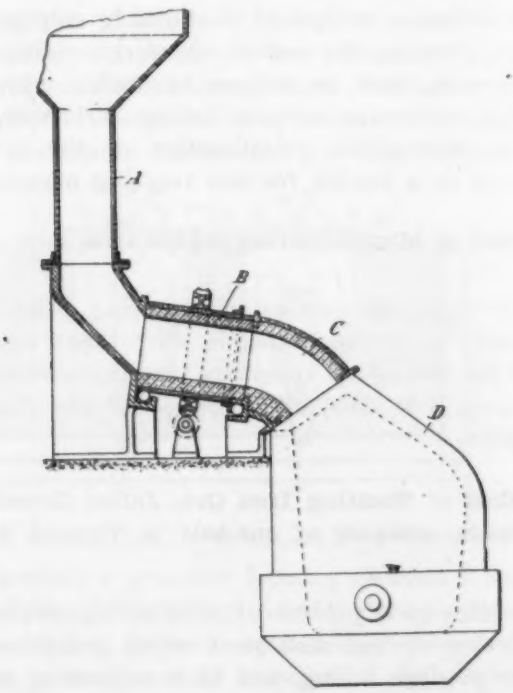
This patent relates to a process of eliminating sulphur from iron ore used in the production of iron and steel which comprises fusing the ore without roasting to produce a slag, and then subjecting the fused mixture to an air blast to eliminate the sulphur and other imprities and then reducing the iron oxides to pig iron or steel in an electric or open hearth furnace, or by any other desired method.

1,550,952, Case-Hardening Composition and Method of Preparing the Same, Ira H. Derby and Carleton B. Edwards, of Indianapolis, Indiana, assignors to Peter C. Reilly, of Indianapolis, Indiana.

This patent states that in the ordinary case-hardening mixture which has been treated with an activator, the activator is usually on the surface of the grains of the carburizing material and comes into direct contact with the steel where it adheres in spots and prevents uniform carburization, this being especially true when the activator consists of sodium carbonate. In order to prevent this the inventors propose to coat the particles of the carburizing compound, which have been treated with an activating material, with a protective shell which may be a coating of pitch which has been heated to drive off the volatile parts of the pitch and leave a carbon coating on the outside of the activated particles of the carburizing compound. This shell or coating protects the steel from contact with the carburizing compound or the activating material, reduces the loss of the carburizing material and brings about many other important advantages which are listed in the patent.

1,551,465, Method of Directly Producing Steel, Alfred Bruninghaus, of Dortmund, Germany.

This patent relates to a method of producing steel directly from iron ore, which comprises charging the ore and flux into a shaft A, where it is

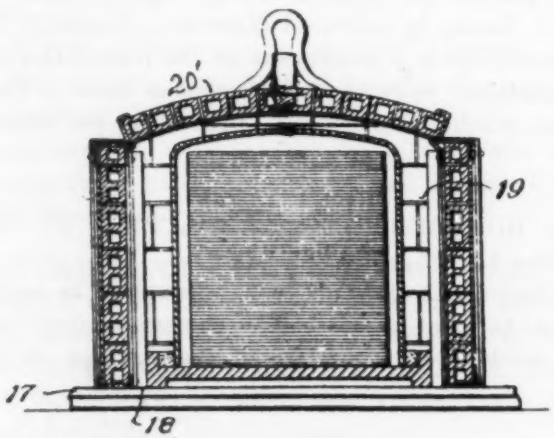


carried in controlled quantities by the rotary pipe B into a Bessemer type converter, C in which a bath of molten iron is maintained. A separate supply of carbonaceous fuel is introduced into the bath and the oxygenated

gas is blown through the bath to reduce the ore and bring the bath to the required percentage of carbon for the iron or steel to be produced.

1,551,745, Method of Annealing Steel or Iron Products, Harry W. Irvin, of Canton, Ohio.

This patent relates to a process of heat treating steel sheets, in which the pile of sheets in the annealing box is removed from the furnace after having been held at the necessary temperature for the required length of time and immediately placed under a hood 20′, which provides an air space



19 around the annealing box to prevent uneven cooling of the box. The walls of the hood are ventilated to still further promote the uniformity of cooling. When the boxes have cooled to the desired point in the hood, the hood may be removed and the sheets removed from the annealing box. By cooling the sheets in this way, it is not necessary to permit the furnace to be cooled off after each annealing operation, the annealed sheets from the preceding operation are removed from the furnace, placed under the hood, and a new batch inserted into the furnace, thereby reducing the time necessary to bring the furnace up to annealing heat and conserving the amount of heat used.

Abstracts of Technical Articles

Brief Reviews of Publications of Interest to Metallurgists and Steel Treaters

PROPER WIRING OF ELECTRICAL EQUIPMENT ON MACHINE TOOLS. By R. C. Deale, in *American Machinist*, August 6, 1925, page 215.

The above article gives a description of the installation of the permanent wiring system electrical equipment for machine tools. The use of circuit breakers and fuse switches is discussed. Controllers and starting switches are also covered.

HARDNESS GOVERNS MACHINABILITY. By James Ward, in *Foundry*, September 1, 1925, page 684.

The author states that the difficulty encountered in machining cast iron causes a problem for the machine shop superintendent and foundryman, inasmuch as the machinability features of the castings are prone to be disregarded.

COOLING CAUSE OF BRITTLENESS. By S. A. Richardson, assistant professor of metallurgy, Lewis Institute, Chicago, in *Iron Trade Review* September 3, 1925, page 550.

The author states that investigation shows that steel castings cooled slowly are less brittle than when cooling is forced. He states that for best results, work of moderate size should be cooled in the mold.

REDUCING STEEL MELTING COSTS. By E. A. Phoenix, Celite Products Co., Los Angeles, in *Iron Trade Review*, September 3, 1925, page 553.

This article shows how the proper insulation of open hearth equipment is an aid to furnace efficiency; also the treatment of roof and walls effect a material saving of fuel. The general installation is described.

ANNEALING LARGE CASTINGS TO PREVENT DISTORTION. By J. A. Capp, engineer, testing laboratory, General Electric Co., Schenectady, N. Y., in *American Machinist*, September 3, 1925, page 385.

In this article is discussed the advantages of double annealing; temperatures maintained and time intervals; difference in treatment of steel and iron castings and lastly performance records to guide future foundry practice.

HEAT TREATMENT OF STEEL DIES. By C. S. Smith, in *Iron Age*, September 3, 1925, page 608.

This paper gives the practical heat treater's methods for oil-hardening non-shrinkable and water-hardening steels.

DIE-CASTINGS MADE OF NON-FERROUS METALS. By Marc Stern, sales engineer, Doehler Die Casting Co., Brooklyn, N. Y., in *Journal* of the Society of Automotive Engineers, September, 1925, page 254.

The author of this article gives a comprehensive description of the present die-casting practices and includes some valuable specific information.

THE OXY-ACETYLENE WELDING OF COPPER. By C. S. Smith, metallurgist, in *Metal Industry*, September, 1925, page 360.

This paper describes experiments which show that copper can be welded without oxidation.

PRODUCTION OF AUTOMOBILE FRONT AXLES. By R. L. Rolf, metallurgist, Columbia Axle Co., Cleveland, in *Forging-Stamping-Heat Treating*, September, 1925, page 293.

The author discusses in a comprehensive manner the important basic designs of automobile front axles. Machinery and routine laboratory inspection are also briefly described.

ONE OF THE CAUSES OF VARIATIONS IN RATES OF GRAPHITIZATION OF WHITE CAST IRON. By Anson Hayes and H. E. Flanders, Iowa State College, Ames, Iowa. Also THE EFFECTS OF SOME MODIFICATIONS OF A RAPID ANNEALING METHOD ON THE PHYSICAL PROPERTIES OF MALLEABLE IRON. By Anson Hayes, E. L. Henderson and G. R. Bessemer, Iowa State College, Ames, Iowa.

These two papers were presented at the annual meeting of the American Foundrymen's Association, Syracuse, October 5 to 9, 1925. The first paper discusses a study made for the purpose of making possible the commercial use of a greatly shortened annealing cycle; while the second paper is a report of a study that is being made of the influences of modification of various rapid methods of annealing upon the physical properties of the product. Results of the authors' investigations of this problem are given.

CUPOLA MELTING RATE AS AFFECTED BY TUYERE RATIOS. By J. Grennan, foundry instructor, University of Michigan, Ann Arbor, Mich. Arbor, Mich.

The above was presented at the annual meeting of the American Foundrymen's Association, Syracuse, October 5 to 9, 1925, and gives the results of a series of experimental heats which were made to determine whether any differences could be noticed in cupola melting when the tuyere area ratios were changed. Observations were taken of the air pressures in the wind belt and cupola, together with the temperature of the iron at the spout as determined by an optical pyrometer. The author has concluded that there is nothing vital in the size of the tuyeres and that small tuyeres do not have a marked influence on the melting.

MECHANICAL AND MAGNETIC HARDNESS. By K. Heindlhofer, S. K. F. Industries, Inc., New York, in *Iron Age*, September 3, 1925, page 606.

In this paper the author discusses the results of alternating current

magnetic readings taken on a large number of hardened ball bearing rings. Most of the rings were heat treated in quantity production according to standard shop practice. The magnetic readings were correlated with the mechanical hardness of the rings. In the average case a simple correlation exists between mechanical and magnetic hardness within the hardness range investigated.

THE EFFECT OF HEAT TREATMENT ON THE PROPERTIES AND MICROSTRUCTURES OF GREY CAST IRON AND SEMI-STEEL. By O. W. Potter, Minneapolis, Minn.

The above paper was presented at the annual meeting of the American Foundrymen's Association, Syracuse, October 5 to 9, 1925, and gives the results of a number of investigations which deal with the effects of ten different heat treatments.

THE ELECTRIC MELTING OF CAST IRON. By George E. Lamb, Hoquiam, Wash.

This paper was presented at the annual meeting of the American Foundrymen's Association, Syracuse, October 5 to 9, 1925. The author discusses the use of the electric furnace in melting cast iron in localities where the cost of suitable materials for cupolas for melting is such that the electric furnace can compete.

CARBON STEEL AND CARBON VANADIUM STEEL BY THE CONVERTER PROCESS. By S. R. Robinson, Bay City, Mich.

The above paper which was presented at the annual meeting of the American Foundrymen's Association, Syracuse, October 5 to 9, 1925, describes a practice carried out by a plant using the converter method of producing steel, and manufacturing such products as locomotive cranes. The writer first gives the physical specification for "as cast" unannealed steel, then discusses the melting and refining equipment used. Refining processes are detailed. Heat treatments for regular carbon steel and for cast tooth gears for extra heavy duty are given. Carbon-vanadium steel practice is also described.

MAKING MISCELLANEOUS STEEL CASTINGS FOR NAVY USE. By D. F. Ducey, U. S. Navy Yard, Puget Sound, Wash.

This paper was presented at the annual meeting of the American Foundrymen's Association, Syracuse, October 5 to 9, 1925, and gives in detail the methods used in managing a steel foundry supplying repair castings for the U. S. Navy.

FACTORS AFFECTING THE HARDNESS OF STEEL. By C. W. Holmes, Standard Steel Spring Co., Coraopolis, Pa., in *Forging-Stamping-Heat Treating*, September, 1925, page 333.

This paper states that the hardness of carbon spring steel is influenced by the temperature to which the steel is heated and the length of time held at that temperature.

News of the Chapters

STANDING OF THE CHAPTERS

IN the September issue of TRANSACTIONS appeared the relative membership standing of the 29 chapters of the Society as of July 1, 1925, and as of August 1, 1925. The tabulation which appears below shows the relative membership standing of the chapters on August 1, 1925, and September 1, 1925.

All of the chapters in Group I maintain the same relative positions as last month with Detroit in the lead by 52 members.

Standing as of September 1

GROUP I	GROUP II	GROUP III
1. Detroit (376)	1. Hartford (121)	1. Tri City (65)
2. Cleveland (324)	2. Lehigh Valley (101)	2. Los Angeles (60)
3. Pittsburgh (295)	3. Golden Gate (88)	3. Rochester (59)
4. Chicago (263)	4. Cincinnati (74)	4. New Haven (56)
5. Philadelphia (256)	5. Syracuse (74)	5. Schenectady (51)
6. Boston (215)	6. Milwaukee (71)	6. Washington (48)
7. New York (209)	7. St. Louis	7. Worcester
	8. Indianapolis	8. Rockford
	9. Buffalo	9. Providence
	10. Northwest	10. Toronto
		11. Springfield
		12. South Bend

Standing as of August 1

GROUP I	GROUP II	GROUP III
1. Detroit (371)	1. Hartford (122)	1. Tri City (66)
2. Cleveland (319)	2. Lehigh Valley (98)	2. Rochester (60)
3. Pittsburgh (290)	3. Golden Gate (95)	3. Los Angeles (60)
4. Chicago (263)	4. Cincinnati (73)	4. New Haven (56)
5. Philadelphia (258)	5. Syracuse (71)	5. Schenectady (50)
6. Boston (223)	6. Milwaukee	6. Washington
7. New York (204)	7. St. Louis	7. Worcester
	8. Indianapolis	8. Rockford
	9. Buffalo	9. Providence
	10. Northwest	10. Toronto
		11. Springfield
		12. South Bend

In Group II the chapters maintain the same standing, although it is expected that all of the groups will be revised somewhat beginning next month due to the fact that the chapters have planned their membership

campaigns and the majority of them will be in full swing by that time.

Group III remains practically the same, the various chapters still holding the same positions as last month.

CINCINNATI CHAPTER

The first meeting of the season 1925-26 was held in the main auditorium of McMicken Hall, University of Cincinnati, where a large gathering of members and their friends witnessed the showing of a motion picture entitled: "The Manufacture and Heat Treatment of Die Blocks," which was presented by G. O. Desautels, Heppenstall Forge and Knife Company. The October meeting of the chapter will be addressed by Major A. E. Bellis, president of the Bellis Heat Treating Company, Branford, Conn., on "Salt Baths." Major Bellis is an authority on this subject and the chapter is fortunate in securing his services for this meeting.

CLEVELAND CHAPTER

A special meeting of Cleveland Chapter, American Society for Steel Treating was held on Wednesday, Sept. 2, 1925, at 8 P. M. in the ball room of the Hotel Winton. The speaker and guest of honor on this occasion was Sir Arthur Balfour, K. B. E., Managing Director of the firm of Arthur Balfour and Co., Ltd., Sheffield, England.

In his address, Mr. Balfour mentioned some interesting facts in connection with the history of tool steel manufacture, and referred to the most recent development in this field both in Great Britain and in the United States. He also discussed the international economic problems which are now being faced by both countries.

This was a joint meeting, members of the Cleveland Engineering Society and the Associated Technical Societies being invited, as well as the A. I. M. M. E. and S. A. E.

110 members and guests attended the banquet at 6:30 P. M. and about 250 were present to hear the address.

A. S. Townsend.

GOLDEN GATE CHAPTER

Meeting: September 16, Hotel Whitecotton, Berkeley, Calif.

Subject: Resumé of the Course on Steel given during the past ten months—C. S. Moody, metallurgist, Caterpillar Tractor Company.

How Automobile Springs are Made—E. Little, superintendent, Hoover Spring Company.

To be reported in November TRANSACTIONS.

HARTFORD CHAPTER

The September meeting of the Hartford Chapter was held Tuesday Evening, September 8th, at the rooms of the Hartford Engineers Club, preceeded by a dinner at the University Club. Mr. J. A. Doyle, Vice President of the W. S. Rockwell Company, spoke on Industrial Heating Problems. Mr. Doyle stated that there was no fuel problem, as it was impossible to

standarize upon a single fuel but that the real problem was one of design and operation of furnaces. The conditions in forge shops are particularly bad, little advance having been made in this field in the last 20 years, especially as regards the working conditions. More heat is wasted by openings in furnaces than it was possible to save by installation of various combustion devices. It was Mr. Doyle's belief that recuperation was not necessary but that hot exhaust gases should be used to preheat cold work. The reason that recuperation was used in Europe was because they were largely compelled to use solid fuels and in order to secure proper combustion it was necessary to preheat the air used. Automatic control of temperature is good evidence of uniform temperature but not proof of uniform quality of product. Particularly in large heats the speaker said, he had seen red, green, and white signal lights in front of a furnace and likewise all colors within the furnace. Mr. Doyle also believed that metallurgical specifications for heat treatment should show how a given time and temperature should be applied and that efficiency of furnaces should be measured in terms of quality of product rather than fuel consumed.

R. W. Woodward.

LEHIGH VALLEY CHAPTER

Meeting: Exhibition Building, Bethlehem Steel Company, Friday, September 11, 1925.

Subject: Rust, Scale and Corrosion Resistant Materials—T. Holland Nelson, vice-president, Wm. T. Bate & Son, Inc., Conshohocken, Pa.
Meeting to be reported in next issue of TRANSACTIONS.

LOS ANGELES CHAPTER

The regular meeting of the Los Angeles Chapter was held August 5th in the office of the Westinghouse Electric and Manufacturing Company.

W. C. Hartman, Jr., of the Union Tool Company, was the speaker of the evening, his subject being "Carburization and Hardening of Carburized Steel."

After a brief history, Mr. Hartman described in a very entertaining manner the various processes in connection with carburization.

In summing up his paper, the principal points brought out were "Pack Hardening Process, Gas Carburization and Heat Treatment of the steel after Carburization."

The members participated in a very interesting discussion after Mr. Hartman's address, at which time many interesting cases of carburized pieces of steel were brought to the attention of the members.

E. C. Black.

Meeting: Office of Westinghouse Electric and Manufacturing Company Building, Wednesday, September 2, 1925.

Subject: History of High Speed Steel—Wm. W. Farrar, Ludlum Steel Company, Los Angeles.
Meeting to be reported in next issue of TRANSACTIONS.

NEW YORK CHAPTER

The New York chapter has recently distributed a very attractive booklet describing the activities of the chapter for the season 1925-1926.

The first meeting of the chapter was held on September 23, in the Merchants' Association rooms, Woolworth Building. A discussion on "Steel Melting," was conducted by Radclyffe Furness, superintendent of the melting and forge department of the Midvale Co., Nicetown, Philadelphia.

Papers which have been scheduled for future meetings of the season are as follows: "Manufacture of Ferro Alloys," on October 21, 1925; Round Table Discussion on Alloy Steels, November 18, 1925; "Flow of Metals in Forging," to be discussed by J. H. Nelson, Wyman-Gordon Co., Worcester, Mass., on December 16, 1925; "Testing of Treated Steels," January 20, 1926. The subject for the February meeting has been left open. The annual smoker is scheduled for March 17, 1926. On April 21, 1926, the subject of "Alloy Steels in Machine Tools," will be taken up, and on May 19, the subject of "Alloy Steels in Automobiles," will be discussed.

MILWAUKEE CHAPTER

The members of the Milwaukee chapter recently elected the following men as officers of the chapter for the year 1925-1926. Chairman, T. A. Moormann; vice-chairman, G. C. Riegal; and secretary-treasurer, N. F. Tisdale; members of the executive committee: H. J. Stein, H. B. Knowlton, H. G. Lloyd, and A. W. Lorenz.

PHILADELPHIA CHAPTER

Meeting: Friday evening, September 25, 1925, Engineers' Club.

Subject: "Effect of Cold-work on Endurance and Other Properties of Metals" and "Effect of Reheating on Cold Drawn Bars," discussed by H. C. Boynton, metallurgist, John A. Roebling's Sons Co., Trenton, N. J.

"Electric Furnace Steel," discussed by R. H. Patch, assistant superintendent, melting department, Midvale Co., Nicetown, Philadelphia.

"Dilatometric Method of Heat Treatment," discussed by J. W. Harsch, research department, Leeds & Northrup Co., Philadelphia.

The Philadelphia chapter of the Society has recently issued a 56-page year book which very capably describes the work of the chapter and the aims and purposes of the Society. This booklet is a history of the activities of the chapter and gives a description of the subjects covered in the course in heat treatment and metallography, sponsored by the chapter and given at Temple University, under the direction of H. C. Knerr. A list of members of the classes in this heat treatment course for each year is given. The entire membership roster of the Philadelphia chapter is likewise included. This publication has been very well prepared and reflects great credit upon those who had to do with its preparation.

On Monday, October 5, started the fifth season of the co-operative evening course in heat treatment and metallography of steel, given under the auspices of the Philadelphia chapter at Temple University. No doubt the enrollment this year will be far in excess of that of last year (when

more than 90 were enrolled), due to the interest which this course has created. In addition to the regular course in the heat treatment and metallography of steel, it is planned this year to supplement it by an advanced course for those who wish to continue their studies beyond the first year's work. This course is designed for those who were enrolled last year and previous years. It will consist of one weekly 3-hour laboratory period for 30 weeks, and the students will be entitled to attend the regular Monday evening lecture period. This advance course is open to those men who have completed the first-year work with a grade of 78 or better or who have had equivalent training or experience elsewhere. The Philadelphia chapter is to be highly commended for this educational movement as it is supplying men of the industry with a means of advancing their technical education.

PITTSBURGH CHAPTER

Meeting: U. S. Bureau of Mines Building, Thursday, September 3, 1925.

Subject: Nickel and Nickel Iron Alloys—Dr. P. D. Merica, director of research, International Nickel Co., New York.

Meeting to be reported in the November issue of TRANSACTIONS.

ROCHESTER CHAPTER

The Rochester Chapter has been very active in preparation of their program for the coming year and have completely filled their schedule. Much credit is due the officers and members of the meetings and papers committee for their efforts. It is a certainty that the Rochester Chapter will enjoy a very prosperous year. The following is the Tentative Schedule of Meetings as outlined for Season 1925-26. (Subject to the approval of Speakers as listed below.)

Date of Meeting.	Speaker.	Subject.
Sept. 25, 1925 Friday.	Sam Tour, Doehler Die Casting Co., Batavia, N. Y.	'Salt Baths'
Oct. 12, 1925 Monday.	C. F. Ipsen, Industrial Heating Dept., G. E. Co., Schenectady, N. Y.	'Electric Furnace Heating as Applied, To Heat Treating.'
Nov. 9, 1925 Monday.	A. W. F. Green, John Illingsworth Co., Philadelphia, Penna.	'Manufacture of Crucible Tool Steel.'
Dec. 14, 1925 Monday.	Dr. Zay Jeffries, Research Bureau, Aluminum Co., of America, Cleveland, O.	'Heat Treatment of Aluminum and Aluminum Alloys.'
Jan. 11, 1926 Monday.	John Howe Hall, Taylor-Wharton Iron & Steel Co.,, High Bridge, N. J.	'Manganese Steel.'

Feb. 8, 1926 Monday.	T. D. Lynch, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.	'Specification of Materials.'
March 8, 1926 Monday.	E. E. Thum, Oxweld Acetelyene Co., New York City.	'Subject Relative to Welding.'
April 12, 1926 Monday.	J. V. Emmons, Cleveland Twist Drill Co., Cleveland, Ohio.	'Machinability of Steel.'
May 10, 1926	Election of Officers.	

It is expected that the chapter will be honored with a visit at one of our meetings by our National President and Secretary; but no date has been set.

ST. LOUIS CHAPTER

The regular monthly meetings of the Saint Louis Chapter opened with a meeting on September 4th, which was held as usual at the American-Annex Hotel.

In spite of the hottest day of the summer, 102 degrees in the shade, C. E. Hellenberg, engineer, Wilson-Maeulen Co., Detroit Michigan, the speaker of the evening, drew a large and enthusiastic crowd, who forgot all about the heat after the meeting began.

Mr. Hellenberg's subject was "Hardness Testing" which he very ably handled as shown by the interest of all those present. He outlined the various types of hardness testers, and elaborated on the various physical properties people endeavor to discover by means of hardness testing. He enumerated experiences encountered in many plants testing different materials and pointed out things which lead to wrong interpretations of hardness results. The talk was illustrated with many interesting slides of the various testers in use, and graphs showing the results obtained on different materials. Mr. Hellenberg demonstrated that on carburized work, if the hardened surface was not of sufficient depth, these results would show up on the Rockwell testing machine. If the carburized case was less than 0.015 inches it would be punctured by the Rockwell. In all hardness tests great care must be given to the surface to be tested; many erroneous conclusions are reached in hardness testing if the work which is tested is not homogeneous. A very interesting discussion followed.

Alan Jackman.

WORCESTER CHAPTER

Meeting: October 1, 1925, Wickwire Spencer Cafeteria, 80 Webster Street.

Subject: The Cleveland Convention and the Papers Presented There, discussed by R. J. Phelon, V. E. Hillman and J. H. Nelson.

EMPLOYMENT SERVICE BUREAU

The employment service bureau is for all members of the Society. If you wish a position, your want ad will be printed at a charge of 50c each insertion in two issues of the Transactions.

This service is also for employers, whether you are members of the Society or not. If you will notify this department of the position you have open, your ad will be published at 50c per insertion in two issues of the Transactions. Fee must accompany copy.

Important Notice

In addressing answers to advertisements on these pages, a stamped envelope containing your letter should be sent to AMERICAN SOCIETY FOR STEEL TREATING, 4600 Prospect Ave., Cleveland, O. It will be forwarded to the proper destination. It is necessary that letters should contain stamps for forwarding.

POSITIONS WANTED

TALLURGIST AND CHEMIST desires position. s had 6 years' experience in steel plant chemical oratory on miscellaneous work and 3 years' ex- ience as metallographist, as well as experience in arch, testing, heat treatment and inspection. Can nish excellent references. Address 10-15.

EMIST with 8 years' experience in ferrous, non- ous alloys, analysis, also metallographic experi- e, desires position. Capable of taking charge of oratory. Excellent references. Address 10-10.

TALLURGIST—Young Chinese interested in sical metallurgy and metallography from the ndpoint of physics, desires position as assistant research laboratory. Age 23 and graduated from chnology school. Prefer to work on problems of n and steel. Can furnish excellent references. dress 9-15.

EMICAL ENGINEERING AND METAL- RGICAL graduate desires position. Has had ee years' experience in the metallurgy of iron l steel, research, testing, heat treatment and pection. Location immaterial. Excellent refer- es. Address 9-5.

POSITIONS OPEN

NTED—High grade young man by long established ufacturer of measuring instruments and tempera- e controlling equipment to qualify as sales engineer cializing on applications for temperature measur- and controlling instruments in heat treatment cesses and similar work in the metal manufac- ng industries. Preference given to candidates ng had experience in use and maintenance of perature measuring instruments and educational ntages in engineering or metallurgical lines. t be free for unlimited travel. Write, stating e, education, experience and salary desired. Ad- s 10-20.

POSITIONS OPEN

WANTED—Young man for production work in high-class repair laboratory for measuring instruments and controlling devices. Wonderful opportunities for promotion to executive positions offered for right man. Individuals having had experience in actual repair work in laboratories for gas or electric meters will receive special consideration. Opportunity offered to receive special training course in factory laboratories of well-known manufacturer in preparation for promotions in branch repair laboratories. Write, stating age, experience, education and salary desired. Address 10-25.

WANTED: Competent man to take charge of a commercial heat treating plant in the Cleveland district. A good position for the right man. Must have had an all-around heat treating experience including carburizing and hardening of tool and high speed steel. Prefer married man 35 to 40 years of age. Address 9-10.

WANTED, A MAN who is thoroughly familiar with tool steel and can sell same, age 25-40, preferably married, to take charge of Chicago warehouse-business, good proposition will be given to the right man who can run business with financial support. Address 9-25.

WANTED

WANTED—Second hand, Hardness Testing Machine. Rockwell or Brinell preferred. Must be in good condition. State make, model, condition and best cash price. Address 10-5.

WANTED: Brinell Machine. State make, model, condition and lowest price. Address 9-1.

FOR SALE

FOR SALE—Used Brinell Machine. Write Boston Gear Works, Norfolk Downs, Mass.

FOR SALE—Commercial heat treating plant doing fairly good business. This is a good opportunity for a practical man. Philadelphia district. Address 10-30.

Items of Interest

THE United States Civil Service Commission announces the following open competitive examinations for the positions of Engineer, $3,800; Associate Engineer, $3,000; Assistant Engineer, $2,400.

Receipt of applications for the positions listed will close October 20. The examinations are to fill vacancies occurring in the Federal classfied service throughout the United States. At present there are two vacancies in the position of assistant electrical engineer, Bureau of Mines, for duty at Pittsburgh, Pa., and one vacancy in the position of associate engineer (naval architecture) in the Bureau of Construction and Repair, Navy Department.

Competitors will not be required to report for examination at any place, but will be rated on their education, experience, and fitness; and writings to be filed with the application.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post office or customhouse in any city.

Ralph S. Poister, formerly open hearth superintendent at the Alan Wood Iron and Steel Co., Conshohocken, Pa., is now metallurgical engineer with the Electrometallurgical Sales Corp., 817 Oliver Building, Pittsburgh.

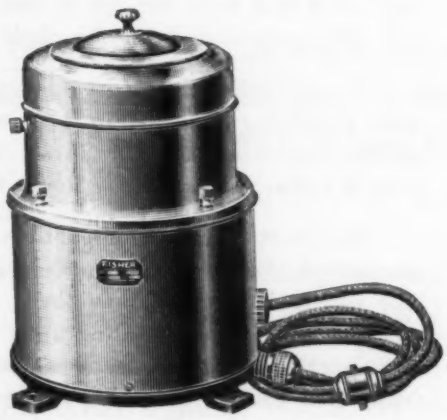
Dr. R. W. Woodward has resigned his position as chief metallurgist with the Whitney Mfg. Co., Hartford, to become associated with the Stanley P. Rockwell Company, consulting metallurgical engineers of Hartford. The latter company is now placing on the market the Rockwell Dilatometer, an equipment for the precise heat treatment of steel, and Dr. Woodward will have charge of this department, as well as being available for general consulting practice. Dr. Woodward was formerly chief of the section of Mechanical Metallurgy at the Bureau of Standards, and has had a wide experience in the metallurgy of both ferrous and non-ferrous metals.

The Cyclops Steel Company has announced the removal of their offices from 1224 Oregon Avenue to 825 Guarantee Title Building, Cleveland, Karl M. Knapp being district manager.

The Carnegie Steel Company, Pittsburgh, have published a new edition of their book entitled, "The Making, Shaping and Treating of Steel." This, the fourth edition of this book within six years, makes available to the public a volume that is practically a new work upon the metallurgy of iron and steel.

(Continued on Page 36 Adv. Sec.)

NEW FISHER POLISHING MACHINE



An independent unit for preparing metal surfaces with which separate heads can be used so that the same machine may be used for either fine grinding or for polishing.

The polisher consists of a vertical motor with a polishing disc directly connected to the motor shaft. Motor is mounted on a circular cast-iron base which has three (3) legs and holes for attaching to a table. Mounted on the base, and surrounding the motor, is a cylindrical nickel plated brass housing. On top of this housing is bolted a nickel plated copper bowl which completely surrounds the polishing head. This bowl is provided with a drain which draws off the polishing liquid caught in the bowl. It is also provided with a nickel plated copper cover which protects the disc from dust, when not in use.

It has a 6 inch polishing head of finished cast iron with hard rubber disc on top, for holding the polishing felt. A special counterbalanced clamping device enables the operator to quickly attach or remove the felt.

The motor can be operated on either 110 volts A.C. or D.C.; normal speed about 1700 r.p.m.

Outfit supplied with polishing head and felt disc; with cord, pendent-switch and plug. **Each, $95.00**

FISHER LEVIGATED ALUMINA

for Metallographic Polishing

This alumina is now recognized by the leading metallographists as the most satisfactory material for polishing metal surfaces for microscopical examination and photography, and is recommended in the newer text books on this subject.

FISHER ALUMINA. Grade No. 1. For all hard metals. One ounce with 50 ounces of distilled water makes the correct polishing solution. **Per ounce, $1.00**

FISHER ALUMINA. Grade No. 2. For medium hard metals. Especially suitable for cast iron bronze, brass and all nickel and copper alloys. One ounce makes 100 ounces of correct polishing solution. **Per ounce, $1.40**

FISHER ALUMINA. Grade No. 3. For very soft metals and other metal specimens for investigation under highest possible magnifications. One ounce makes 150 ounces of correct polishing solution. **Per ounce, $1.80**

SCIENTIFIC MATERIALS COMPANY

"Everything for the Laboratory"

PITTSBURGH, PA.

While the book was originally written mainly as a text and reference book for employes of the company, this edition has been expanded to meet the needs of all the subsidiary companies of the United States Steel Corporation, not only as a text book for use in the schools conducted by the various companies but as a reference book for their employes.

We are officially informed that the Union Minière du Haut Katanga are now producing and will offer their cobalt metal, salts and oxides, on this market beginning early in November. Enquiries may be addressed to the company's Cobalt Department, Room 609, 67 Wall Street, New York City.

The metallurgical department of the Milwaukee Vocational School announces their evening course comprising one year's work in metallurgy. The course is divided into three sections; that of metallurgy; heat treatment of steel and metallography of iron and steel. The first part is an elementary course for users of metals, teaching the classification, selection, properties and uses of the various kinds of cast iron, wrought iron, steel brass, bronze, etc. The course is designed for practical shop men who desire a technical education. The division dealing with the heat treatment of steel consists of lectures, demonstration and actual furnace practice in the annealing, hardening, tempering and heat treatment of the various kinds of steel. The third division deals with the microscopic study of the various kinds of iron and steel, showing the use of the microscope and determining the cost of success or failure of iron and steel parts. This course is under the supervision of H. B. Knowlton.

William J. Priestly has been transferred to the home office of the Electro-Metallurgical Sales Corporation, 30 West 42nd Street, New York. He was formerly located at 817 Oliver Building, Pittsburgh, Pa. Mr. Priestly is assistant general sales manager of the above company, and assistant general sales manager of the electrode division of the National Carbon Company. R. S. Poister has been employed to succeed Mr. Priestly as metallurgical engineer at Pittsburgh, effective October 1st. He was formerly connected with the United Alloy Steel Corporation, Canton, Ohio, and then with the Alan Wood Iron & Steel Company, Norristown, Pa.

Frederick E. Mesta, recently elected president of the Mesta Machine Co., West Homestead, Pa., died suddenly Aug. 31 at Pittsburgh. Mr. Mesta was born Aug. 4, 1876, in Bethel township, Allegheny County, Pa. He obtained his preparatory education at the Leechburg, Pa., high school, in which city he was first associated with the iron and steel industry with the Leechburg Foundry & Machine Co. In 1898 he took charge of the construction of the present plant of the Mesta Machine Co. and was made general superintendent. Admitted to directorship and made vice-president in 1912, he held his position until the recent death of his brother, George Mesta, brought him the post of chief executive of the company.

J. W. Griffiths, recently connected with the Bethlehem Steel Co. as superintendent of open hearths, has established himself as a consultant with com-

(Continued on Page 38 Adv. Sec.)

Permanent Magnet Steel

Composition is but one factor in the making of Permanent Magnet Steels. Thermal treatments before the steel goes to the customer are governing factors in obtaining proper values in finished magnets.

Simonds magnet steels are furnished in both Tungsten and Chromium grades in sheets, strips or bars. When required in the annealed condition, a special anneal is given, depending on the method of magnet manufacture. This anneal, while softening sufficiently to allow of cold working or blanking, is so regulated as to prevent loss of magnetic properties. Ordinary annealing will lower perceptibly these important values.

We maintain a magnetic testing laboratory for our own development work and to co-operate with our customers in helping them to produce a product of the highest quality. This service and our experience are available to those interested in producing high grade permanent magnets for meters, magnetos, radio work and the like.

We welcome the opportunity to improve your product, and to solve any of your present problems.

SIMONDS STEEL MILLS
LOCKPORT, N. Y.

SIMONDS

panies experiencing difficulties in special steel manufacture. His address is 1306 Twelfth Street, N. W., Canton, O. Mr. Griffiths has been in the steel industry for 25 years, formerly having been with the United Alloy Steel Corp., Canton, O., and the Central Steel Co., Massillon, O.

John McConnell, formerly vice-president in charge of operations of the United Alloy Steel Corp., Canton, O., has joined the organization of the Donner Steel Co., Inc., Buffalo, in a consulting and advisory capacity.

The Crucible Steel Co. of America, New York, has opened a warehouse in Hartford, Conn., at 131 Clark Street. The building is one-story high, of fireproof construction, 80 x 220 feet. The New Haven branch was formerly at 47 York Street. F. J. Dawless is manager. Associated with him are H. A. Scallen and Edward Morrissey.

E. A. Whitworth has resigned as general superintendent of the Upson plant of the Bourne-Fuller Co., Cleveland, and has become associated with the Gathmann Engineering Co., Baltimore, manufacturers of ingot molds. His headquarters will be in Cleveland.

P. A. Hopkins has resigned as chief engineer of the Penn Spring Works, Baldwinsville, N. Y., after having been connected with the company for 9 years and has organized the Leaf Spring & Service Corporation, Syracuse, N. Y. This organization, of which Mr. Hopkins is president and general manager, will render service on springs and bumpers to passenger-car and truck owners in Syracuse and central New York.

M. L. Frey, formerly assistant research metallurgist with the Holt Tractor Company, Peoria, Ill., now known as the Caterpillar Tractor Company, has joined the technical staff of the Gerlinger Electric Steel Casting Company, West Allis, Wis., as chief metallurgist and research engineer. Mr. Frey, together with Fred Grotts of the Holt Company, have contributed to technical literature on heat treatment of cast iron and cast steels.

John Younger will be head of the department of industrial engineering that will be inaugurated this fall at the college of engineering at Ohio State University, Columbus. The purpose of the course is to train future engineering executives and to give a broad view of administrative problems to engineering students. Mr. Younger was formerly chief engineer of the truck division of the Pierce-Arrow Motor Car Co., Buffalo; chief of the engineering division, Motor Transport Corps; and vice-president of the Standard Parts Co., Cleveland; and latterly owner and editor of *Automotive Abstracts*, Cleveland.

Leeds & Northrup Co., Philadelphia, have recently published their new catalog No. 93, which describes a new development, and is entitled, "The Homo Method for the Drawing of Steel." The chapters of this booklet include: 1. The correct drawing of steel tools and parts is vital to long life and

(Continued on Page 40 Adv. Sec.)

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ELYRIA, OHIO

to low cost of production; 2. Difficulties encountered in practice; 3. Ideal equipment for drawing on a production basis; 4. Equipment to meet exactly the ideal conditions for correct drawing; 5. The homo electric drawing furnace; 6. The homo drawing method; 7. Price list of homo equipment.

Eight appointments as research fellows and one as research engineer have been made to conduct investigations of problems in mining and metallurgy this coming year in cooperation with the U. S. Bureau of Mines, according to an announcement from the Carnegie Institute of Technology.

Six different institutions are represented among the appointments. According to the announcement, 56 applications were made this year for research fellowships in mining and metallurgy, the applicants representing 27 colleges and universities in the United States and Canada. Applications were also received from students in China, India, Japan, England, Norway, Belgium and Germany.

The appointees to mining fellowships are: Russell B. Cooper, Johnstown, Pa., University of Pennsylvania; C. O. Hawk, Felicity, Ohio, Ohio University; Garnet Phillips, Terre Haute, Ind., Rose Polytechnic Institute; B. E. Hess, Huntington Park, Cal., California Institute of Technology; and H. F. McCullough, Scottdale, Pa., special appointment as research engineer.

The following were named as research fellows in metallurgy: Abraham Grodner, Pittsburgh, Carnegie Institute of Technology; Ralph B. Norton, Eastondale, Mass., Massachusetts Institute of Technology; Gustave H. Pfeiffer, Terre Haute, Ind., Rose Polytechnic Institute; and E. A. Hertzell, Schuylkill Haven, Pa., Pennsylvania State College.

The research program in mining and metallurgy at Carnegie Tech for the next college year is announced as a continuation of the cooperative arrangements that have been in effect with the Bureau of Mines in mining for the past five years and in metallurgy for the past two years. Two different advisory boards, composed of coal operators and engineers in the one case, and of steel manufacturers, engineers, and metallurgists in the other, have approved the problems to be investigated, and will cooperate financially in carrying out the program.

Problems selected in mining have been assigned as follows:

"The composition of tar and oil from the low temperature distillation of coal," by R. L. Brown, organic chemist, Bureau of Mines, and R. B. Cooper, research fellow.

"Study of simple catalytic attachments to electric cap lamps, for detecting methane," by W. P. Yant, associate chemist, Bureau of Mines, and C. O. Hawk, Research fellow.

"Time-pressure relations in combustion of the fine sizes of coal-dust," by C. M. Pouton, associate research chemist, and Garnet Phillips, research fellow.

"A study of the propagation of flame in mixtures of natural gas and air," by H. F. Coward, principal assistant, Safety in Mines Research Board, England; G. W. Jones, associate chemical technologist, Bureau of Mines; and B. E. Hess, research fellow.

(Continued on Page 54 Adv. Sec.)

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Choose any one of our

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The Cheapest Method if equipped to do so, is to make up your own bath as needed, using as a basis—

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CYANIDE SODIUM 96/98%

guaranteed 51/52% cyanogen
strength equal to 128/130% KCN

Dilute with Soda Ash and Salt, to suit

Our mixtures are also highly suitable for reheating after pack hardening
Better heating medium than lead—prevent oxidation

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to low cost of production; 2. Difficulties encountered in practice; 3. Ideal equipment for drawing on a production basis; 4. Equipment to meet exactly the ideal conditions for correct drawing; 5. The homo electric drawing furnace; 6. The homo drawing method; 7. Price list of homo equipment.

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Six different institutions are represented among the appointments. According to the announcement, 56 applications were made this year for research fellowships in mining and metallurgy, the applicants representing 27 colleges and universities in the United States and Canada. Applications were also received from students in China, India, Japan, England, Norway, Belgium and Germany.

The appointees to mining fellowships are: Russell B. Cooper, Johnstown, Pa., University of Pennsylvania; C. O. Hawk, Felicity, Ohio, Ohio University; Garnet Phillips, Terre Haute, Ind., Rose Polytechnic Institute; B. E. Hess, Huntington Park, Cal., California Institute of Technology; and H. F. McCullough, Scottdale, Pa., special appointment as research engineer.

The following were named as research fellows in metallurgy: Abraham Grodner, Pittsburgh, Carnegie Institute of Technology; Ralph B. Norton, Eastondale, Mass., Massachusetts Institute of Technology; Gustave H. Pfeiffer, Terre Haute, Ind., Rose Polytechnic Institute; and E. A. Hertzell, Schuylkill Haven, Pa., Pennsylvania State College.

The research program in mining and metallurgy at Carnegie Tech for the next college year is announced as a continuation of the cooperative arrangements that have been in effect with the Bureau of Mines in mining for the past five years and in metallurgy for the past two years. Two different advisory boards, composed of coal operators and engineers in the one case, and of steel manufacturers, engineers, and metallurgists in the other, have approved the problems to be investigated, and will cooperate financially in carrying out the program.

Problems selected in mining have been assigned as follows:

"The composition of tar and oil from the low temperature distillation of coal," by R. L. Brown, organic chemist, Bureau of Mines, and R. B. Cooper, research fellow.

"Study of simple catalytic attachments to electric cap lamps, for detecting methane," by W. P. Yant, associate chemist, Bureau of Mines, and C. O. Hawk, Research fellow.

"Time-pressure relations in combustion of the fine sizes of coal-dust," by C. M. Pouton, associate research chemist, and Garnet Phillips, research fellow.

"A study of the propagation of flame in mixtures of natural gas and air," by H. F. Coward, principal assistant, Safety in Mines Research Board, England; G. W. Jones, associate chemical technologist, Bureau of Mines; and B. E. Hess, research fellow.

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(Continued from page 40 Adv. Sec.)

"A field study of underground coal loading machines and mining methods adaptable," by J. W. Paul, mining engineer, Bureau of Mines, and H. F. McCullough, research engineer.

Assignment of the studies in metallurgy are announced as follows.

"A study of the cause and control of abnormality of case carburized steels," by C. E. Sims, electrometallurgist, Bureau of Mines, and R. B. Norton, research fellow.

"A study of the open hearth steel furnace atmosphere in relation to its effect upon refractories," by F. W. Schroeder, assistant chemist, Bureau of Mines, and G. H. Pfeiffer, research fellow.

"A study of the mechanism of corrosion and the factors effective in its control, in steam power plant operation," by R. E. Hall, physical chemist, Bureau of Mines, and E. A. Hertzell, research fellow.

"Temperature and heat-flow studies in open hearth and electric steel furnaces," by B. M. Larsen, metallurgist, Bureau of Mines, and Abraham Grodner, research fellow.

The Brown Instrument Company announced the opening of a Los Angeles Branch at 363 New High Street, Los Angeles, Calif., with Mr. S. F. Godfrey, late of The Braun Corporation, as District Manager.

Articles of incorporation having been filed in California, this branch will carry stock and conduct its own accounting direct with its customers.

Users of Brown pyrometers, recording thermometers, electric CO_2 meters, electric SO_2 meters, pressure gages, tachometers, draft gages, etc., will appreciate this new branch office.

A complete repair department is maintained and customers are assured of thorough Brown Service in every way.

L. M. Zimmer has been appointed general sales manager of the Linde Air Products Company, manufacturers of oxygen, and of the welding gas division of The Prest-O-Lite Company, Inc., manufacturers of dissolved acetylene, succeeding L. M. Moyer, who resigned August 1st, 1925.

Mr. Zimmer entered the employ of the Linde Company nine years ago as junior salesman, and has steadily risen in rank. Most of the time he has represented the company in the Central West, coming to New York early in 1924 to act as assistant general sales manager.

It has been announced that Arlington Bensel has taken over the exclusive sales agency for "Hybnickel" Alloy Products, with an office at 300 Madison Ave., New York City. This organization consists of a research laboratory with a staff of enginers who have been engaged in the nickel business for many years in co-operation with the firm of Pusey & Jones Company. In his twenty years of experience in the nickel alloy field, Mr. Bensel has done some important pioneering work and will be able to offer a type of sales and engineering service which will be very acceptable to the industry.

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